THE UNFOLDING UNIVERSE

EDGAR L. HEERMANCE

THE UNFOLDING UNIVERSE

THE UNFOLDING UNIVERSE

BY

EDGAR L. HEERMANCE

THE PILGRIM PRESS

BOSTON NEW YORK CHICAGO

FOREWORD

What is the universe of which we are a part? What is its meaning? What is our life, and whence, and whither? These questions are perennials; they spring up year after year without our planting. Not so with the answers. Man must wring them from a reluctant Nature by the sweat of his brow.

This book attempts to sketch the contributions made by the various sciences toward a philosophy of the universe. It grows out of the conviction, to which philosophy has been strangely blind, that the inductive method is the only method of thinking which is reliable or fruitful. Scientific study has opened up the rich fields of modern thought by driving observation and hypothesis abreast. Why should science have a monopoly of such a team? I offer this book as the outline of an inductive philosophy.

The task of the sciences is to gather facts in their respective fields. The function of philosophy is supposed to be to interpret those facts and arrange them into a consistent whole. If philosophy is in bad repute in many quarters, it is because she has forgotten her place as the handmaid of the sciences. Learned men find it easy, sitting in their studies, to think what the universe ought to be like, or to build an eclectic philosophy, stone by stone, out of the ruined systems of the past. But—to change the figure—while the professional philosopher has been spinning his gossamer theories of matter and life, the physicist and the biologist have been studying matter and life and making remarkable discoveries as to their texture. Much the same is true in the broad field of psychology. The philosophy that men want today, I believe, is the philosophy which, on the foundation of what is known to us through the several sciences, builds its inductions as to the unknown beyond them all.

Within two decades almost every science has passed through a period of revolution. We live in a new intellectual world. The attempts at inductive philosophy made a generation ago are as out of date as textbooks in physics or neurology or comparative mythology of the same vintage. Doubtless some will say that it is too early to frame the new knowledge into a system of philosophy. But that same new knowledge is already modifying our thinking. In scientific books and papers of today, in scouting expeditions into the realm of science like those of James and Bergson, are to be found the beginnings of new and strange philosophies. I am reminded of the Scotsman who was asked to drink. "Naa," he replied, "it's twa early. Besides, I've had a gill a'ready."

This book is not a treatise on the new knowledge in various fields. For that I must refer the reader to the eleventh edition of the Encyclopædia Britannica, already out of date at many points, but supplemented by the Britannica Year Book; to the files of the best scientific periodicals; and to a well-selected library which has consigned to the lumber room most books published earlier than about 1895. I have not even attempted a bibliography. As a general rule, references are given in the footnotes only for direct quotations and for authorities on new or disputed points. I must feel rather than express our debt to the thousands of scientific workers in many lands.

I have selected my material, merely by way of suggestion and summary, in preparation for the philosophical discussion with which each chapter or part closes. This method lends itself to clearness and objectivity, if not to literary brilliance. The very fact that the general reader is likely to find the first chapters hard reading, because of his lack of familiarity with the subjects treated, shows the necessity for summarizing recent discoveries before their bearing can be discussed intelligently. Scientific slang is avoided wherever possible.

With the exception of the historical and sociological sections of the book, my material has necessarily been gathered at second hand. It is no longer possible for one man to attempt Spencer's task of being a specialist on all subjects. I have tried to follow what seemed to me the best scientific thought in each field, not being afraid of novelty but avoiding fads. Errors of statement and of judgment are inevitable. My hope is that they will not be of such a character as seriously to affect the argument. In the chapter on The Universal Energy I have attempted some generalizations of my own, simply because the generalizations which the physicists ought to be giving us were not forthcoming. In the later chapters, notably that on the classification of religions, I have marshalled my own material, in order that, through fresh inductions, I might avoid becoming entangled in some current terms and theories which appear to me erroneous. If the reader is stimulated to follow up this or other parts of the new knowledge, I shall be glad. But my primary purpose is to interpret that knowledge and stimulate others to the task of interpretation.

Once more, this book is not a work in theology, though I make bold to think it has some bearings on a needed reconstruction of theology. The book is the by-product of a busy pastorate in the West, which has kept me in touch with humanity in its religious and social needs. But if charged with a theological bias, I think I can honestly plead "Not guilty." As far as was humanly possible, I have avoided all preconceived ideas as to what were the facts of the universe, or how they were to be interpreted. For much of the seventeen years during which the book has been in preparation, I was not sure of the final positions to which I might be led. I have tried to keep the door of my mind open, or at least to leave the latch-string hanging out. I ask the same courtesy of the reader.

Further than this the book must serve as its own introduction. If my sketch-plan of the universe is not full enough, O fellow sophist, I urge you to fill it in from your better equipment or your more abundant leisure. If my philosophy does not satisfy you, give the world a truer or a broader one, along the inductive lines I have suggested. A philosophy along any other lines is mere playing with words. *A priori* thinking, like higher mathematics, will continue to have its place as a mental discipline and as a threshing out of possibilities. But the possible is only the husk of the real. In method let us be empiricists. The facts may lead us in the end to the position of idealism, but if so it will not be, to use Hegel's immortal phrase, "an idealism shot out of a pistol."

Of the many friends who have assisted me by criticism and suggestion, Professor Arthur W. Ewell of the Worcester Polytechnic Institute and Professor Norton A. Kent of Boston University deserve my special thanks. They should not be held responsible for scientific deadwood still unpruned.

INTERNATIONAL FALLS, MINNESOTA
September 10th, 1914

OUTLINE OF CONTENTS

INTRODUCTORY

CHAPTER I

KNOWING THE WORLD

PART ONE. THE PHYSICAL

CHAPTER II

THE STARS

CHAPTER III

ELECTRONS

CHAPTER IV

IS THERE AN ÆTHER?

CHAPTER V

THE UNIVERSAL ENERGY

PART TWO. THE ORGANIC

CHAPTER VI

THE EVOLUTION OF LIFE

OUTLINE OF CONTENTS

CHAPTER VII

THE CELL

CHAPTER VIII

HOW FAR DOES CHEMISTRY CARRY US?

CHAPTER IX

THE ORIGIN OF LIFE

PART THREE. THE PSYCHICAL

CHAPTER X

THE EVOLUTION OF MAN

CHAPTER XI

THE CENTRAL NERVOUS SYSTEM

CHAPTER XII

NERVE-CELLS AND REFLEXES

CHAPTER XIII

THE HUMAN MIND

CHAPTER XIV

THE SUBCONSCIOUS

CHAPTER XV

A NEW DEFINITION OF PERSONALITY

CHAPTER XVI

THE HIGHER LIFE OF MAN

CHAPTER XVII

THE SHADOWS OF HISTORY

PART FOUR. THE SPIRITUAL

CHAPTER XVIII

THE SOCIAL STAGES OF RELIGION

CHAPTER XIX

RELIGION AND PSYCHOLOGY

CHAPTER XX

COMMUNION

CHAPTER XXI

INSPIRATION

CHAPTER XXII

PHYSICAL EFFECTS

CHAPTER XXIII

CONVERSION

CHAPTER XXIV

THE RELIGIOUS HYPOTHESIS

CHAPTER XXV

THE REPUBLIC OF GOD

CHARTS AND ILLUSTRATIONS

INTRODUCTORY

CHAPTER I

KNOWING THE WORLD

HOW do we know? This question confronts us at the beginning of any serious work in philosophy. It demands an answer before we proceed. The thinker must have a working theory of knowledge, clearly defined in his own mind and plainly expressed for the guidance of his readers.

My position may be summarized as follows. The ideas or concepts which we use in our thought have their basis in our experience of the external world. They represent habitual occurrences, relations and characters that have come under our observation. The breadth of our experience makes such abstraction necessary; the symbolism of words renders it possible. The concepts represented by words are objectively valid only when concretely applied, since the process of abstraction has been merely for convenience in handling the great mass of material.

Our mental faculties have developed by adjustment to the spacial world in which we live. Within that world, therefore, we are powerful. Throughout that world, knowledge is the correlate of being. Whatever is, is knowable, in a sense, simply because it is. All we need is the vantage-point from which to observe it.

Whether we can penetrate beyond that spacial world remains to be seen.

To the philosophy which discards the *a priori* and reasons solely from experience, the actual is the only possible, though the actual may have bounds beyond the widest horizon of human observation. This principle follows from the detailed study we are about to make of the process of human thought and the validity of ideas. It should be stated in the form of a warning as we start our introductory chapter. If we heed this warning, we may not form as many or as elaborate theories, but we shall know fewer things that are not so.

The abstractions which we call ideas are precious; we must be extremely careful in our use of them. The actual is, legitimately, the sole basis of the hypothetical. The material of our knowledge is derived from observed facts. From the observed facts, also, must be derived the hypotheses by which we seek to arrange and explain this material. In inductive philosophy, as in inductive science, while in a sense there is only one canon—that any hypothesis is legitimate which can make good—at the same time there is a *law of parsimony that forbids us to form any theory to which the facts themselves do not compel us.* The theory which we form may be a trial theory that further study may lead us to reject, but it must be a hypothesis honestly derived from the facts before us. It cannot be mere guesswork, a toying with possibilities, the superstition of some "phlogiston" escaping in chemical decomposition, or of the mind secreting thought as the liver secretes bile—a fancy that the moon is made of green cheese, or that a book of philosophy is necessarily as dull as its first chapter. The reader who is not interested in theories of knowledge is advised to pass over the remaining sections, in which I develop the position outlined above.

How do we know? Our point of view is suggested by the form given to the question. I do not ask: "Is it possible to know?" That we do know, in some sense, that we reach a satisfactory degree of certitude, is evidenced in various ways. For one thing, language proves it. All the higher languages have words for "knowing" and "knowledge." Again, our daily life implies knowledge. Man has that power in action which comes only from mental certitude; he can because he kens. A man "knows" that the sun will rise tomorrow. His experience has taught him that it has always done so; he has drawn the conclusion that it always will. He adjusts his life and work accordingly. And the theory works; it is constantly confirmed by new facts of experience. What he calls the sun does do what he calls rising on what he calls the morrow. Our whole life is built upon this and similar items of knowledge. Without them we should be powerless, afraid to move, unable to do a stroke of work.*

The progress of science is a progress in knowledge, in certitude. Ask the scientist: Is it possible to know?

* Though developed independently, this position is practically identical with that taken by Prof. Dewey and his co-workers in their *Studies in Logical Theory,* 1909.

and he will answer, if he deigns to answer at all, by pointing to the world's libraries, its laboratories, its factories, its pneumatic drills and wireless telegraphs, its geologic time-scale, its spectrum analysis, its prediction of eclipses, the evolution of the horse's hoof or the process by which a cell's nucleus divides. And the knowledge of science, like that of daily life, is inductive—it is derived from experience. We reach our general laws through the study of individual cases. By gathering and classifying and generalizing certain facts of experience, we form a working theory of these facts. We apply this theory—or hypothesis—to the facts, testing it, correcting it when necessary, even substituting a new one that better accords with the facts.

If any reader needs a definition of induction, he may gather it from the following outline of a typical inductive process. Kepler's work in astronomy furnishes as good an example as any. Starting with Copernicus' idea of the revolution of the planets in circles, he proceeded to test it by elaborate calculations based on the positions of Mars. He was surprised to find that Mars travelled in an ellipse, with the sun as one of its foci. Further calculation gave him the law that a planet's velocity throughout the ellipse is not uniform, but varies in a certain inverse ratio according to its distance from the sun. The reason for these laws was not apparent until Newton's studies on universal gravitation, and Kepler's own explanations were fantastic. But the laws themselves served as working hypotheses.

By direct study Kepler extended them to the earth. He then reasoned by analogy that they must hold true of the other planets, an assumption confirmed by later studies.

This is the same process which our common man goes through in reasoning about the sunrise; only in Kepler's case it was carried out systematically and with a wider store of observations. Modern psychology has shown that, outside of medieval logic books, all thinking which advances our knowledge is inductive in character. We do not mumble over the old deductive formula: all cats are vertebrates; Tommy is a cat; therefore Tommy is a vertebrate. We proceed to dissect Tommy, and fit the discoveries we make into the framework of our previous knowledge. John Stuart Mill has been justified in his position that "all inference, consequently all proof, and all discovery of truths not self-evident, consists of inductions, and the interpretation of inductions: that all our knowledge, not intuitive, comes to us exclusively from that source."* We do not think in syllogisms; we think in experiences. All conclusions are hypotheses.

Here is a lesson for philosophy. She must, under pain of death, adopt the systematized inductive method which has been used by science in the last century with such conspicuous success. If we are to learn the nature of the universe, or of personality, or of God, it must be in the same way as the physicist learns the nature of radium or of negative electricity. We must observe,

* *Logic,* Bk. III, Chap. 1.

and form hypotheses based on the facts before us. The test of our hypothesis is whether it works or not—whether renewed observation confirms or discredits it. No other method of reasoning is acceptable today. We have no valid knowledge except that derived from experience, broadly considered.

Philosophy should have learned this lesson even before the Age of Science. Kant reduced to absurdity all *a priori* thinking—the thinking we do prior to experience. The great critic never did a better piece of work than in his *Antinomy of Pure Reason,* where the abstract ideas of earlier systems are made to destroy one another, like the cats of Kilkenny. Since Kant's day, all *a priori* thinking ought to be under the ban. Such speculation is valueless for extending our knowledge. Inductive study has taken its place.

The knowledge, the state of mental certitude, which we reach by this process is not absolute, either in daily life or in science and philosophy. Since knowledge is derived from experience, absolute knowledge would require an absolute experience, covering all facts and relations which may ever exist. This men do not possess, even collectively. Our knowledge is constantly subject to enlargement and revision. By this constant revision it approaches the absolute truth, which we hold before us as an ideal and to which we suppose all our knowledge to be in relation. For example, the theory of the permanence of species gave place to the theory of the gradual evolution of species through natural selection. The first had a large element of truth in it. It served man as a working hypothesis for several thousand years. It did an invaluable service in preparing the way for the second. And finally it gave way to evolution as a truer theory. But he would be bold indeed who claimed that we have at length reached absolute certainty. It is now doubtful whether natural selection is a positive factor in evolution. We know vastly more about the origin of species than did our fathers. Yet we have gone but a little way on our pilgrimage toward the truth. To reach that goal we are studying still, correcting, generalizing anew, and our descendants will be doing the same to the world's end. It is the relativity of all knowledge which lends a zest to its pursuit.

Probability, as Butler teaches us, is the guide of life. We have no other guide. Induction can give us nothing more satisfying. But the problem becomes more complex when we pass from the possibility of knowing at all to the value of our knowledge for purposes of thought. Strange as it may seem, the certitude which is adequate for practical life or even for science may be entirely inadequate for philosophy. It has proved to be so with many modern thinkers. "The evolution of species!" they would say to the scientist. "You claim to derive this from the facts of your experience, which is doubtless true. But that means that you derive it from your states of consciousness. You have made a beautiful synthesis out of your states of consciousness. Have you done more than that? Have you really learned anything of the external world? What is 'species' itself but an idea, the product of your synthetic faculty?"

This philosophical scepticism is seriously meant and must be answered seriously. I can only outline my reply; to discuss the subject fully would require a separate treatise on the theory of knowledge. I will first state my own view, and then give a specific instance of scepticism and suggest the answer.

Briefly my position, the position reached by modern psychological study, is this: While our knowledge and the experience on which it is directly based are undoubtedly facts of consciousness, our knowledge and experience are not confined to the facts of consciousness for their field. Simply because all knowledge comes through consciousness, it is not necessarily limited to consciousness. Any knowledge of the self and its states implies, by an evident non-identity, knowledge that the "not-self" exists. As a matter of fact, the not-self is more fully and accurately known than the self. This must be apparent to every one on a moment's reflection. Descriptive psychology, which deals with the self, bulks very small in human thought in comparison with the sciences which deal with the not-self, and the progress of our knowledge in its field has been slight comparatively. Again, the not-self comes earlier into conscious thought than the self, in the history of the child and of the race. In animals, and in children before consciousness of the self arises, there is a consciousness of the external world and a practical knowledge of it. All of which goes to show that our knowledge is more than the synthesizing of our states of consciousness. It is a real knowledge of a real external world, relative no doubt, not to our states of consciousness, but to those facts which we represent by the expressions "ultimate reality" and "absolute truth." Human thought, in its inductions, shows a constant adjustment to the experienced facts of the external world.

For a concrete example of scepticism we may best turn to Kant, its greatest exponent. He is the champion whom every modern thinker must meet. When Kant denied the objective validity of metaphysical ideas, he based his argument principally on the synthetical character of all our mental processes. Upon the material furnished by the senses the mind imposes its own intuitive forms. These forms exist prior to experience. The mental processes which involve them and are shaped by them can teach us nothing as to the source of the material furnished by the senses; that is, as to the nature of things in themselves. Hence our knowledge is necessarily subjective, not objective, which practically means that philosophy must go out of business. That is Kant's position. The intuition of space, as given in his *Æsthetic,* is as good an instance as any. For Kant this is an *a priori* form imposed by the mind. For us it is first a form and later an idea derived by the mind from its experience of a spacial world. I suggest the reasons for holding this view of space, leaving the reader to follow out a similar method of proof for other sides of my general position.

Child psychology, which has grown up since Kant's day, shows us that there is no idea or form of space existing *a priori* in the human mind. Space perception is acquired by a long process of seeing and touching. The child must learn space, adjust itself to space. This is one of the commonplaces of psychological study today.

We turn also to animal psychology, another relatively new science. Experiments of great interest have been made on new-born chickens and pigs.* At first the evidence of animal psychology appears to contradict that from child life. Space is innate, as Kant claimed for the human mind; the reactions of the animal to distance, direction, size, etc., are instinctive. "In the ways he moves, the directions he takes and the objects he reacts to, the chicken has prior to experience the power of appropriate reaction to facts . . . of all three dimensions."† It makes no difference whether we consider instinct as the product of inherited adjustment, and say, with Romanes, that heredity has done the work for which experience is required in children, or whether, with Professor Loeb, we resolve it into a series of tropisms. In either case this spacial instinct shows the adjustment of animal faculty to a spacial world. In fact, it proves the existence of a spacial world, in very much the same way as the development of the eye organ in living creatures in response to

* Douglass Spalding, *Macmillan's Mag.*, XXVII, 282 (1873); *Nature,* XII, 507. Thorndike, as below.

† Edward Thorndike, *Psychological Review,* 1899, 282; since reprinted in his *Animal Intelligence,* 1911.

waves of light proves the objective reality of waves of light.

It follows therefore that the inductions of practical life, of science, of philosophy, when involving space (as the single point I have chosen for illustrative proof) carry us beyond our states of consciousness. They are more than syntheses of these states; they increase our working knowledge of the external world. What space is in itself, as a "form" of phenomena, need not detain us now. It is first a form of certain external objects. Then, when we induce this form as belonging to all phenomena, it becomes a category or general concept, employed by the mind in further inductive processes. This making space an idea is but the logical conclusion of the mind's adjustment to that world which is the sphere of its practical activities.

The stages of this mental adjustment to the external world, the process by which the facts of the external world become knowledge, is a subject so important to the right use of philosophy that I must take it up in some detail. We have still to answer the question with which we started: "How do we know?"

A suggestive discussion of the different stages of thought was given by Romanes, from the standpoint of comparative psychology.* I shall use his outline and terms, without meaning to commit myself to the associationist view of mental processes. Consciousness is undoubtedly a stream rather than a mere aggregation

* G. J. Romanes, *Mental Evolution in Animals,* 1883; *Mental Evolution in Man,* 1888.

of drops, and Romanes' terms may be made to fit this point of view. Another fair criticism, which will not affect my argument, is that Romanes' animals are too precocious, that he uniformly attributes to them a higher place in the mental scale than the facts will warrant.

1. *Percepts.* A perception, as Romanes says, involves a process of mentally interpreting sensations in terms of past experience. This begins among animals at about the level of echinoderms, and in human infants at the age of one week. The first stage is the perception of an external object as such by any of the senses. Then follows recognition of the simplest qualities of the object—size, form, color, height, rest, motion—as like or unlike the qualities presented by such an object in past experience.

"Perceptions," says Romanes, "are dependent on subconscious coordination wholly automatic." Let us stop a moment to determine the objective validity of such elementary percepts. We do not perceive sensations; we interpret sensations so as to perceive objects. Let me offer the following incident from the experience of the canker worm as an illustration. Certain reflected light waves reach the organism and result in sensations of sight in the nerve centers. Having had before what were apparently the same sight sensations, the insect larva attains a percept of an extended green object. Having had pleasant taste sensations in the past under similar circumstances, the larva forms a new percept that includes this sensation and proceeds to feed upon the object. This description of the mental state of the canker worm on an apple leaf is crude and probably erroneous, but it serves to illustrate the formation of a percept, with the consequent reaction, among animals of the lower stages. Now this perception of an object is quite valid, from the standpoint of reality. Leaving taste aside, to simplify the illustration, there is something in the external world whose chemical constitution is such as to absorb all waves of white light except those of a certain wave length that we call green, and whose form when reflecting these light waves has a definite size and shape.

As for the existence of the object as an entity, we may say that, just as for convenience in mastication we divide our food into bites, so we separate the external world into objects for purposes of mental mastication. Instead of a leaf, we may at other times make an object of the cluster or the tree or the grove. The area of the visual world which we select is determined by the focussing of attention, and varies in a rough proportion as the square of the distance which the reflected waves of light must travel to reach us. What we shall select as object, however, is largely determined for us by certain ways in which groups of phenomena are related in the external world. Each group has its boundaries. The leaf is bounded by the air, the grove by the meadow land.

2. *Recepts*. Percepts become in their turn objects of memory. There enter the principle of association by contiguity in consciousness, in molluscs and

infants seven weeks old, and the principle of association by perceived similarity, in fish and children of four months. From this point we find abstraction and generalization beginning. Prior to the rise of self-consciousness we have what Romanes terms recepts, "spontaneous associations, formed unintentionally by what may be termed unperceived abstractions." Animals above a certain stage can form such receptual ideas as "good-for-eating," "not-good-for-eating," and under this head come generic ideas of "dog," "man," etc. A talking bird is able to learn names and use them correctly as *notæ* or marks of particular objects, qualities and actions, and even farther. The parrot extends the name "bow-wow" from a particular dog to dogs in general. But "the parrot will never extend its denotative name of a particular dog to the picture or even the image of a dog." A child will do this, and Romanes calls it a higher recept, perhaps paralleled by the intelligence of non-talking animals.

Let us pause again to ask the value of a receptual idea, for example, "dog." It is a composite idea, formed by combining many simple ideas or percepts. But recepts are *received*—"the comparing, sifting, and combining is here done, as it were, *for* the conscious agent, not *by* him." It is still a mental mastication of the external world. Having bitten off as object a certain group of phenomena, we sort out similar groups as we meet them in our experience. If we made an object of the whole collection, this process would be as objectively valid as the last. "Dogs" exist, just as much as "a dog" exists. But abstraction has begun to enter the process. We concentrate our attention on what is similar in all dogs, what distinguishes them from wolves, for example, and neglect the individual differences—of size, color, etc. We make an object of this abstraction. The species "dog" does *not* exist in the external world, though men, whether philosophers or totem peoples, were perhaps justified in thinking that it did, until Darwin and his colleagues demonstrated the impermanence of species. The recept "dog" is objectively valid only when it is resolved into terms of one or more individuals of the species to which the recept refers.

3. *Concepts.* Passing to the higher ranges of mental life, exclusively human, by lower concepts we are to understand named recepts, provided the naming is due to reflective thought. Language and self-consciousness develop together, and conceptual thought is their joint product. By a higher concept Romanes understands an idea fully recognized *as* an idea. When a child names the color "red," with a full consciousness of what is covered by the term, we have a lower concept. When it speaks of "redness" or "color," the idea is a higher concept.

This distinction between lower and higher concepts is not of great importance, as it simply indicates greater or less abstractness. Objective reality may be claimed for concepts on exactly the same terms as for recepts, from which they are directly or indirectly derived. That is, they must be applied to objects which we have perceived or are perceiving. There is no "color" in the world, but only violet, indigo, blue, green, etc. Furthermore there is, psychologically considered, no "green," apart from particular objects so constituted that they appear to us as green. To take further examples, we have the number concepts in mathematics and the concept of causality in physics. In each of these cases, the concept must be applied to and stated in terms of concrete experience before it becomes objectively valid. The worker in philosophy must constantly bear in mind this abstract character of the concept. Failure to do so has proved a fruitful source of error. Each "idea" must be challenged and compelled to give its pedigree.

The problem of phenomena and noumena need not detain us. Whether such a distinction should be made, what is the nature of "things in themselves," what is the relation of our microcosm to a possible macrocosm—all these are questions of fact, to be settled, if at all, by the inductive method which we have seen to be valid for all thinking.

PART I

THE PHYSICAL

CHAPTER II

THE STARS

A BRIEF work of definition is necessary at the outset. I shall find it convenient to use occasionally the terms "natural" and "supernatural." As these words are apt to be given a loose and more or less theological meaning, it is essential that my own use of them be clearly understood. "Natural" and "supernatural" are correlates: the second is derived from the first. By "natural" I mean the customary. A "supernatural" event is simply an exception to the customary. It follows that the specific meaning of these terms will vary according to the sphere in which they are applied.

If we take the facts of the world historically, from the point of view of their development, we may distinguish four groups of phenomena, or spheres of reality—the physical, the organic, the psychical and the spiritual. The first three are recognized in some sense by all thinkers, but the legitimacy of the last, or spiritual, group is still a matter of debate. In each there is a natural order. The appearance of supernatural events in our study of that order furnishes the point of transition to the natural order of a higher group.

So far as man's observation (direct or indirect) has gone, all the facts of the universe before a certain geologic date—that is, before the appearance of life on this planet—may be classified under physical laws. The same classification covers a vast group of phenomena that we are now observing side by side with the organic and other groups. In this great sphere of reality, the natural is the physical, because the physical is here the customary. We find no facts that are not physical. Whatever physical categories we may discover are everywhere applicable.

Turning to the field of astronomy, we find that recent years have seen a notable advance in knowledge, due largely to the use of the spectroscope. We have been obliged to make a complete revision of our ideas in many directions.

Let us consider first the structure of the universe. The most satisfactory hypothesis at present is that the stellar universe, of which we are a part, is of limited rather than indefinite extent. Many facts point in this direction. As a result of the improvement of telescopes and photographic appliances there has been developed a law of diminishing returns in the number of new stars discovered. This suggests that we are beginning to approach the limit in the number of existing stars. Up to the tenth magnitude the number of stars goes on increasing steadily in about the proportion we should expect if the stars extended indefinitely (nearly four times the number for each successive magnitude). But after that point the ratio rapidly falls off. If the total number of stars was infinite, it is hard to see why the number should not go on quadrupling with each magnitude up to the very limits of telescopic vision. In some parts of the sky there are starless rifts where many astronomers consider that we are looking completely through the stellar universe.

One of the main arguments for this position is that furnished by the study of optics. The total light given by the stars is limited and comparatively small in amount, whereas from innumerable stars we should theoretically have an amount of light greater than that from the sun. Prof. Newcomb's popular statement of the question will be worth quoting. "Suppose the stars to be scattered through infinite space in such a way that every great portion of space is, in the general average, about equally rich in stars. Then imagine that, at some great distance, say that of the average stars of the sixth magnitude, we describe a sphere having its center in our system. Outside this sphere, describe another one, having a radius greater by a certain quantity, which we may call S. Outside that let there be another of a radius yet greater by S, and so on indefinitely. Thus we shall have an endless succession of concentric spherical shells, each of the same thickness, S. The volume of each of these regions will be nearly proportional to the square of the diameters of the spheres which bound it. Hence, supposing an equal distribution of the stars, each of the regions will contain a number of stars increasing as the square of the radius of the region. Since the amount of light which we receive from each individual star is as the inverse square of its distance, it follows that the sum-total of the light received from each of these spherical shells will be equal. Thus, as we include sphere after sphere, we add equal amounts of light without limit. The result of the successive addition of these equal quantities, increasing without limit, would be that if the system of stars extended out indefinitely the whole heavens would be filled with a blaze of light as bright as the sun. Now, as a matter of fact, such is very far from being the case. It follows that infinite space is not occupied by the stars. At best there can only be collections of stars at great distances apart. . . . . So far as our present light goes, we must conclude that, although we are unable to set absolute bounds to the universe, yet the great mass of stars is included within a limited space the extent of which we have as yet no evidence. Outside of this space there may be scattered stars or invisible systems. But if these systems exist, they are distinct from our own."*

The only way of escaping this conclusion is by supposing that some of the light from the stars is extinguished before it reaches us. Struve propounded this view a good many years ago. But science has shown conclusively that mere distance will not bring about such extinction. Light rays can travel indefinitely in the perfect vacuum of inter-stellar space. Recently dark stars have been suggested as possible extinguishers, also the particles of "star dust" out of which future nebulæ may be formed. But in the more distant stars observed by us there is nothing to suggest that any

* Simon Newcomb, *The Stars,* 299 *ff.*

appreciable portion of their light has been cut off. If we are able to see the telescopic stars just as they are, there is no reason why we should suppose the light from ultra-telescopic stars to be extinguished.

As to the total number of the stars we must be satisfied with very general figures. Gore's estimate is that the number of bright stars in the universe, down to the seventeenth magnitude, which is close to the present limit of telescopic vision, does not exceed one hundred million. Newcomb's estimate is somewhat higher; he says "hundreds of millions."

As to the distribution of the stars, they appear to be scattered with a certain degree of uniformity through a sphere flattened at the poles and with somewhat irregular boundaries. Around this sphere extends the belt of the Galaxy, or Milky Way, roughly circular in cross-section, composed of a very much denser aggregation of star-clusters and individual stars. Probably the "star density" of the stellar sphere increases near the Galaxy, to a greater degree than is explained by a mere flattening of the poles, making the plane of the Milky Way, to use Sir William Herschel's expression, "a plane of ultimate reference, the ground plan of the sidereal system." Whether there are any stars of this sphere beyond the Galaxy, that is, whether the Milky Way is at the boundary of the stellar universe or not, is still uncertain. The solar system is at about the center of the stellar sphere and in the plane of the Galaxy.

The sun has a diameter of 864,000 miles (as compared with 8,000 miles for the earth and 88,000 for Jupiter) and is at a distance from the earth of nearly 93,000,000 miles. The distance from us of the nearest of the regular stars, Alpha Centauri in the southern hemisphere, is about 275,000 times that of the sun. Light travels 186,000 miles a second, or about 5,870,-000,000,000 (five trillion, eight hundred seventy billion) miles a year. The light from Alpha Centauri, therefore, takes about four and one-half years to reach us, and the farthest stars are probably at a distance of at least 3,000 light-years. Newcomb estimated the average distance of each star from every other, in the stellar sphere, at six and one-half light-years.

Some of the stars are smaller than our sun; many of them are very much larger—perhaps a thousand times as large, or even more. The great difference, however, is in luminosity rather than in mass. All the stars observed appear to have motions toward or around some center, at considerable velocity. Large groups of stars are also moving together. The study of this subject is still in its infancy but it has already been possible to distinguish two star-drifts, dividing the stars about equally between them. They are intermingled, one system being apparently superposed upon the other. One appears to be moving about one and one-half times faster than the other. This drift theory has superseded the idea that the sun is moving independently toward a definite point in the sky. Conclusions are still uncertain, especially as we have only begun to measure approaching and recessional motions as well as motions across our line of vision. Some exceptions to these drifts have been found, and the theory is being revised year by year.

The use of spectrum analysis for the study of stellar light has enabled us to classify the stars. Three main classes are commonly distinguished. The lines of the spectra show dark, for the most part, owing to absorption by the layer of gas surrounding the star. Class I contains more than half the stars and an even larger proportion of those especially brilliant. They give a white or slightly bluish light. Their spectra show the presence of hydrogen and helium in the absorbing layer, though the effect of metallic vapors can also be detected. These stars are gaseous, of great size and comparatively small density. They are found mainly in the Milky Way. The stars of this class shade gradually into Class II, to which our sun belongs. These stars give a yellow light and show the spectra of most of the elements with which we are familiar. They are probably gaseous or liquid. Class III is composed of stars giving a red light and having fluted spectra, indicating the presence in their atmospheres of metallic compounds and carbon in vapor form. The physical state of these stars is still uncertain. In some cases bright lines are present. A group of comparatively small stars, with reversed fluted spectra, are probably to be included in this class; these compose Secchi's Class IV. Professor Pickering has proposed a Class V to include a group of over a hundred stars of peculiar spectra, with bright as well as dark lines, suggesting some incandescent gases in their atmospheres as well as merely absorptive vapors. Another considerable group, the Wolf-Rayet stars, seem to combine, among other peculiarities, the characteristics of Class II and Class V. They are confined to the galactic regions, and tend to gather in groups. Still another class would include the numerous dark stars discovered. These are difficult to detect, but they may turn out to be as numerous as the bright stars with which they are associated.

Besides these classes of fixed stars there are other groups or forms of great importance. A large number of double stars are being discovered, as well as some triple and even multiple systems. They are in revolution around their common center of gravity, though the orbit is often eccentric. The numerous dark stars discovered are part of such binary or multiple systems. It is possible that single stars will prove to be the exception. Where the two stars of a binary are unequal in size, they frequently have spectra belonging to different classes. The distance between them is sometimes comparatively small. The companion of Capella, for instance, is at about the same distance as the earth from the sun. There are also the numerous star-clusters, sometimes containing thousands of stars. They are most numerous in the Milky Way, where stars are thickest. Their stars show spectra of Class I, though sometimes with the hydrogen lines bright. They are often associated with wisps of nebulous matter. It is still an unsolved problem why these hundreds or thousands of stars, crowded into a comparatively small space, do not gravitate together into a single mass. Possibly this process is slowly taking place.

One of the most striking facts about the star-clusters is the number of variable stars which they contain—more than half of those discovered. These variables are of different classes. A few stars are known to be gradually changing in brightness. Others show irregular fluctuations; the best known instance, Eta Argus, is in the midst of a nebula. The so-called "new stars," which are likely to prove numerous, especially in the star-clusters, suddenly blaze out with increased brilliance, and after a few weeks or months fade. Their spectra show bright hydrogen lines, so that the brightness is largely due to incandescent hydrogen gas; the bright lines are not always constant. But there seem often to be two spectra, one of them resembling that of the nebulæ. Some of these variable stars have certainly turned into nebulæ. The cause of the cataclysm is still in doubt; probably both collision and explosion enter into it.

There are also several classes of periodic variables. Some of these, like Algol, are now known to be eclipsed at intervals by dark companions. Further variation in the periods of such stars may be due to the presence of smaller planets, not yet discovered. Other types seem to show a binary system of gaseous stars, not only eclipsing one another but so tenuous as to be drawn out into ellipsoids by their mutual attraction. This is probably true of all periodic variables. Some of the binaries are considered to be in actual contact. Mr. A. W. Roberts states that five out of the twenty-two Algol variables revolve in contact, taking the form of a dumb-bell. In one other the stars have recently parted company. The periods of all periodic stars are comparatively short, ranging from a few hours to two years.

The nebulæ are not found to any extent in the Milky Way, except for certain large diffused forms. In the rest of the sky they are very numerous, possibly numbering several hundred thousand. Some of the nebulæ are spiral, some ring-shaped, some extremely irregular in form and either continuous or fissured. In many cases one or more stars are embedded in the nebula. There is often a nucleus, with a star at the center. In the spiral nebulæ the stars are arranged more or less symmetrically, following the curves of the spiral, with other stars in curves outside of the nebula at present visible. The nebulæ are of enormous extent, some of them probably thousands of times the diameter of our whole solar system. They often tend to vary both in form and brightness. The spectrum of about half the number is that of luminous gas, showing lines of hydrogen, an unidentified element called "nebulium," and in some cases helium. The spectrum of the remainder, the "white" nebulæ, is continuous, like ordinary stars or star-clusters of Class I. The density of the nebulæ has not been determined, but it is so small that most of them are transparent. What is their exact nature, whether they contain solid particles, and what is the cause of their luminescence, are still mooted questions.

Astronomers are agreed that the observed facts show a constant process of evolution, and perhaps devolution also, among the stars. Laying aside for the moment the question of origins, the main course of this stellar evolution seems to be clear, as follows: Lane's law states that "when a spherical mass of incandescent gas contracts through the loss of its heat by radiation into space, its temperature continually becomes higher as long as the gaseous condition is retained." This process is going on in many, perhaps all, of the stars. They begin as nebulæ, as Laplace assumed for our solar system more than a century ago. The fact of stars embedded in nebulæ and the similarity between star-clusters and the various nebular forms show an unmistakable connection. In fact, the present sky shows all stages of condensation from diffused nebulæ to systems of gaseous stars. The stars of Class V, with their incandescent gases, may be the earliest, though this is still uncertain. Then come the stars of Class I, with their enormous size, low density, great brilliance, and a reversing layer that causes the lines of the spectrum to appear dark for the most part. Further condensation, with an accompanying rise in temperature, is seen in Class II. The point at which the maximum temperature is reached is not certain; perhaps it is about the stage of our sun, whose temperature is estimated at 6,000° C. Absorption by the reversing layer causes the light here to be yellow rather than blue. The Lick

Observatory has made the interesting discovery that the older stars are moving more rapidly. After the maximum temperature is reached, the stars cool off by radiation, passing through the stage of Class III with their dense atmospheres. The dark stars are the end of the series, unless stars in various stages are liable to suffer accidents and be resolved again into nebulous or meteoric matter. This may occasionally happen through collision. It is more likely that when two bodies pass each other within a recognized limit of distance (Roche's limit) the smaller body will be torn into fragments by gravitational attraction. We have evidence of such accidents in the asteroids, meteors and comets; also in the new stars which turn into nebulæ.

This general process of evolution enables us to explain the distribution of the nebulæ with reference to the Milky Way. Nebulæ are rare there, while star-clusters are numerous. In the Galaxy most of the nebulæ have condensed into clusters, and the presence of variable stars in these clusters suggests that changes are going on in them and that the fluctuations in brilliance are due to their youth. The other striking feature of the Milky Way is the number of stars of Class I, which we know to be young. Some of these are very large, but the great proportion are very small and near together. It is possible that the latter* constitute the first aggregations of former nebulous matter and later

* It is simply an inference as yet that these belong to Class I.

will unite to form larger stars. Older stars are more rare, which may indicate more frequent accidents. Nebulous or meteoric matter left from accidents would be more quickly attracted by stars, as these are more numerous. It would seem that the Milky Way as a whole must be rotating, as only this could have formed and preserved such a vast ring. The central region, to which our solar system belongs, is probably a region of comparative calm, the chances of collision being infinitesimal.

Laplace's famous hypothesis is correct in its recognition of the nebula as a primitive type from which other forms have been evolved by condensation. For the idea in this form credit should perhaps be given to the elder Herschel rather than to Laplace. In its details the original nebular hypothesis is largely outgrown. The tidal theory has taken the place of the theory of rotating rings. Although the latter may have operated in some cases, the number of ring nebulæ is comparatively small. Prof. G. H. Darwin, studying the effect of lunar tides on the earth in its original fluid state, found that they affected the shape of the earth, and this in turn affected the moon's orbit, accelerating its velocity and increasing its distance from the earth. The moon's orbit also tended to grow more and more eccentric. Working backward, he discovered that the moon must originally have formed part of the earth, from which it was separated by tidal action. Dr. See applied this to the double stars, whose orbits are highly eccentric, and found the same effects of tidal action.

The ordinary process seems to be for a nebula to divide into two nearly equal parts, which separate from one another very much as the moon separated from the earth. Recent studies on the variable stars have given us actual evidence of this process. If the rotating nebula is very heterogeneous, in temperature for instance, the portion detached will be smaller, so that the comparatively small planets of our systems may have originated in tidal action. Our solar system however is, up to the present, unique in the heavens, all other systems known to us having at least two stars, bright or dark, of nearly equal mass.

The meteoric hypothesis, now widely current, aims to explain the origin of nebulæ, and to some extent the formation of stars. It considers that many parts of the heavens are filled with rapidly-moving particles, which by aggregation produce nebulæ. This theory finds justification, not only in the meteoric matter constantly falling on the earth, but still more in the fine particles constituting the rings of Saturn, the tails of comets, shooting stars, and the zodiacal light. The meteoric hypothesis does not conflict with the idea of a nebula as gaseous, since a gas is composed of rapidly-moving particles. It may supplement the tidal theory, explaining the origin of bodies which subsequently divide as stated above. Proctor and others have carried the theory further. They consider that the planets of our solar system were formed by a series of aggregations. The larger centers, represented by the larger planets, were at a greater distance from the center. The inner centers were not able to capture so much meteoric dust.

Much light is likely to be thrown on the meteoric hypothesis by the electrons of the new physics, to be described in the next chapter. There is a constant leakage of electricity from hot bodies, and electrons must be emitted from the sun in enormous quantities. This undoubtedly has something to do with the sun's corona. It causes the Aurora, probably through the stoppage of flying electrons by our atmosphere. The tail of a comet, made up of electrons, is constantly emitting electrons into space. These phenomena suggest what is the material of which nebulæ are formed. And their luminosity is probably caused by impacts of some sort.

The stars show most of the commoner chemical elements. In many instances, however, the spectra of certain elements appear in a simplified or "dissociated" form, the number of lines being vastly reduced. Thus there is a reduction for iron in the sun from nearly 1,000 lines in the reversing layer to two in the chromosphere above. The same phenomenon appears in the stars, especially those of Class I. The explanation is still in doubt. Some think it is due to proto-metals, or to the atom being decomposed under high temperature.

The life of a star will depend partly upon its initial mass; the larger the nebula the longer the period of contraction. Up to a short time ago, 20,000,000 years was the total time usually allowed for the sun to continue radiating energy at its present rate, by condensation alone. (Maintenance of temperature by bombardment from meteoric particles is untenable, on various grounds.) This period, none too long for the earth's biological development, would of course be only a fraction of its life as a star.

The discovery of radioactivity, however, has compelled us to reconsider this whole question. We know that helium is present in the sun, and helium is intimately associated with radium. A comparatively small quantity of radioactive matter would enable the sun to maintain its heat indefinitely from this source. A similar source of energy would be the rearrangement of other atoms, with the release of some of their internal energy. "An equivalent statement of the same conclusion may be put thus: supposing a gaseous nebula is destined to condense into a sun, the elementary matter of which it is composed will develop in the process into our known terrestrial and solar elements, parting with energy as it does so." * Further application of our knowledge of radioactivity will be awaited with great interest.

What contribution has Astronomy made toward a solution of the broad philosophical questions? From the facts already before us, what is our interpretation of the world in which we live?

The world is certainly a unity. That is one of the facts clearly established by modern science. The same physical laws which are familiar to us on the earth and

* R. A. Sampson, *Enc. Brit.,* art. *Sun,* XXVI, 88 c.

in the solar system hold good in the farthest corner of the stellar system. Gravitation, for instance, everywhere follows the same course. So does the radiation of light. The elements found in earth, sun, stars and nebulæ appear to be identical. About half of the known elements have already been detected in the sun. Some of the stars, perhaps all stars in a certain stage, have spectra closely resembling that of the sun. In the meteorites constantly falling on the earth, originating possibly in some distant part of the heavens, not a single non-terrestrial element has been found. Altogether twenty-four elements have been found in meteorites, including seven not found in the sun.

That our solar system forms part of the stellar system and that the whole is dynamically related is universally recognized by scientific observers, even if little has been done as yet toward working out the orbits of such relation. It is proper for us to conceive of our world as a universe. We are compelled to think of physical phenomena in their totality.

This notion of a universe is a distinct contribution to our thought. For it is an objectively valid concept, extremely abstract, it is true, but derived from our experience of the external world, and concretely applicable as we fill in the many parts and occurrences included in the universe.

We have learned further that the universe has definite dimensions. It comprises a certain number of stars, although an immense number, which as yet we can only estimate. These stars extend from us in all directions to certain definite distances—vast distances, which, however, we are beginning to measure. What is beyond the farthest stars? We do not know. Are there other universes beyond the limits of our own? We do not know. We have not the slightest evidence for the existence of any other universe, and the law of parsimony forbids our postulating another universe without evidence.* Our thought is necessarily restricted to the one we know. Men of this age cannot follow the custom of the ancients, when their knowledge gave out, and draw a sea serpent or a dragon at the edge of the map.

* See *ante,* p. 4.

CHAPTER III

ELECTRONS

TURNING from the telescope to the microscope, what does the "new physics" tell us as to the nature of that which is called matter?

In the first place, what appears to us as solid or fluid is in reality made up of extremely small particles, or atoms, usually grouped into what we know as molecules. The atomic theory, beginning as a hypothesis, and considered by many philosophers a physical fiction, is now proved beyond dispute. Single atoms or parts of atoms have been isolated by at least three different methods and their effects noted.* The camera reveals the single shots of their bombardment as well as if they came from thirteen-inch guns. We can count them, measure them, calculate their rate of speed. And what may be photographed and counted and measured may not lightly be dismissed as something hypothetical, symbolical, fictitious. We live in a physical world, and that world is made up of atoms. Which only adds interest to the question: "What is an atom?"

Physics is now prepared to tell us much as to the structure of the atom. About three-quarters of a century ago, Faraday studied the conduction of electricity through certain compound liquids known as electro-

* Phosphorescent spots on a piece of sulphide due to impinging alpha particles; Rutherford's experiment of passing alpha particles through a hole; and the isolation of electrons by Thomson and Milliken through drops of water or oil.

lytes. He discovered the law that the quantity of the electrolyte decomposed is proportional to the amount of electricity passing through it. This he explained by the theory of the ion (that is, "traveller"), an atom or group of atoms bearing an electric charge. These ions are of two kinds, one drifting toward the positive pole or anode, the other drifting in an opposite direction to give up its charge at the negative pole or cathode.*

This conception has now been applied to the conduction of electricity through gases. Gases ordinarily are very poor conductors of electricity. Their conductivity may be increased, however, by lowering the pressure. As early as 1859 Plücker passed an electric charge through a tube connected with an air-pump. As the pressure was lowered, the passage of electricity became easier, the spark changing to a continuous glow, until finally a stream of radiations, since known as cathode rays, was obtained from the cathode. It was not until 1895 that Röntgen discovered certain invisible radiations outside the cathode-ray tube. These X or Röntgen rays have many unusual properties, among them the power of making conductors of air and other gases.

Sir William Crookes was the first to recognize that cathode rays consist of minute particles bearing a neg-

* Copper-plating furnishes a simple example. Under the influence of the electric current, some of the molecules of the copper sulphate bath are decomposed. The copper molecule or ion passes to the object to be plated, which forms the cathode. The sulphate ion goes to the copper plate forming the anode, which dissolves, thus forming new molecules of copper sulphate and keeping the bath of uniform strength.

ative charge. That is, they are negative ions. But in this case the ion is very much smaller than the atom. Professor J. J. Thomson of Cambridge, by a series of brilliant experiments, succeeded in determining the mass of these "corpuscles," as he called them, though the term "electron" is now more generally used. Our knowledge has been extended by many other experimenters. Each electron, when moving with moderate velocity, has an apparent mass approximately 1/1700 of the mass of the hydrogen atom.* This apparent mass is the same whatever the element. This is also true of the electric charge carried by the electron, which has been accurately measured.† This electronic charge is probably to be considered as "a real natural unit of electricity," all ions carrying one such unit or a multiple of it.‡ It is interesting to note that the theory of unit electrons was worked out mathematically before the experimental study of cathode rays, notably by Lorentz in Holland and Larmor in England.

Corresponding to the electrons are the particles in the vacuum tube carrying an equivalent positive charge.

* The fraction generally used. Fleming in the *Encyclopædia Britannica,* 11th ed. (art. *Electricity,* IX, 192, note 2) gives the masses as 7.0×10^{-28} and 1.3×10^{-24} respectively, or 1/1859. Bücherer, *Annalen der Physik,* XXVIII, 513 (1909), gives 1/1752 for a little less than 1/3 the velocity of light. Thomson's earlier figures, before instruments and methods were perfected, were 1/770 and 1/1170.

† 4.891×10^{-10} E.S. units, is given by R. A. Milliken, *Physical Review,* XXXII, 349 (1911).

‡ H. A. Lorentz, *Theory of Electrons,* Leipzig, 1909, 44.

These positive ions always have a smaller velocity than the electrons, and a very much larger mass. The mass, however, is not constant, but differs for each element. It is of the same order as the mass of the ion in ordinary electrolysis, though not necessarily identical with the atom. In no case is it smaller than the hydrogen atom.

The effect of Röntgen rays is to "ionize" a gas. That is, some of the molecules give off, or are broken up into, positive and negative ions. Under the influence of an electric field, these particles tend to move toward their respective poles, as in the case of liquids. This constitutes the current, which is proportional to the number of ions reaching the plates in a given time.

We have learned further that the number of electrons in an atom is of the same order as and not greatly different from the atomic weight (hydrogen one, helium four, etc.)* This at once suggests the fascinating hypothesis that the atom of one chemical element differs from that of another only in the number and arrangement of its component electrons. As to the exact constitution of the atom we are still in the dark, although clever guesses have been made by Thomson and others. The general theory of free and bound electrons, the latter moving in definite orbits within the atom, seems to be meeting all the demands made upon it.

The study of radium and other radioactive substances, following the discoveries made by Becquerel

* J. J. Thomson, *Philos. Mag.*, XI, 769 (1906).

and the Curies, in 1896, has given a striking confirmation of the electron theory. The *alpha* rays shot off by these substances are universally recognized as positive ions. They have been further identified as helium atoms with a double charge. The *beta* rays are electrons. The *gamma* rays are now classed, with Röntgen rays, not as particles but rather as light rays with an extremely short wave-length. The alpha and beta particles escape in great numbers and with a wide range of velocities. In many cases the discharge alternates with periods of apparent rest, when the emission of alpha and beta rays cannot be detected.

A simple explanation of these phenomena, based on the electron theory, is that given by Rutherford and Soddy. The radioactive elements are the heaviest known, and hence the most complicated in their structure and most subject to rearrangement and decomposition. "Each second a definite fraction of the number of atoms present break up with explosive violence, in most cases expelling an alpha or beta particle with great velocity. Taking as a simple illustration that an alpha particle is expelled during the explosion, the resulting atom has decreased in mass and possesses chemical and physical properties entirely distinct from the parent atom. A new type of matter has thus appeared as a result of the transformation. The atoms of this new matter are again unstable and break up in turn, the process of successive disintegration of the atom continuing through a number of distinct stages."*

* E. Rutherford, *Enc. Brit.*, XXII, 797 a.

This activity is, in observation as in theory, independent of temperature, chemical combination and all other physical conditions.

The radioactive atoms are to be considered as in process of decomposition. New temporary elements are formed, only to give place to other more or less familiar substances. A radioactive element is now defined as one that is undergoing transmutation, this being detected by the slow decrease of its mass, independent of external conditions. Further study has suggested that all elements may be radioactive. A large number of substances are known to cause ionization, but it is still uncertain whether this is due to the radioactivity of their elements or to the presence of minute quantities of radium or similar material.

In addition to the energy shown in ionization, an amount of heat is given out by the radioactive elements at least 500,000 times greater than in any known chemical reaction, though the rate of emission is slow. This heat must be intrinsic, intra-atomic. The kinetic energy involved in the movements of electrons within such a complicated atom would be enormous.*

* "In 1 gram of hydrogen there are about 6×10^{23} atoms, so if there is only one corpuscle in each atom the energy due to the corpuscles [deduced from the size and charge] in a gram of hydrogen would be 48×10^{16} ergs, or 11×10^{9} calories. This is more than seven times the heat developed by 1 gram of radium, or than that developed by the burning of 5 tons of coal. Thus we see that even ordinary matter contains enormous stores of energy; this energy is fortunately kept fast bound by the corpuscles; if at any time an appreciable fraction were to get free the earth would explode and become a gaseous nebula." J. J. Thomson, *Presidential Address*, 1909.

TABLE OF RADIO-ELEMENTS*

Radioactive Products	Transformation Period	Nature of Rays Emitted	Radioactive Products	Transformation Period	Nature of Rays Emitted
Uranium ↓	5×10^9 years	alpha	Thorium ↓	10^{10} years	alpha
Radiouranium ↓	?	?	Mesothorium 1 ↓	5.5 years	rayless
Uranium X ↓	22 days	beta and gamma	Mesothorium 2 ↓	6.2 hours	beta and gamma
Ionium ↓	?	alpha	Radiothorium ↓	800 days	alpha
Radium ↓	2000 years	alpha	Thorium X ↓	3.7 days	alpha
Emanation ↓	3.75 days	alpha	Emanation ↓	54 seconds	alpha
Radium A ↓	3 minutes	alpha	Thorium A ↓	11 hours	slow beta rays
Radium B ↓	26 minutes	beta and gamma	Thorium B ↓	1 hour	alpha
Radium C ↓	19 minutes	alpha, beta and gamma	Thorium C ↓	?	alpha, beta and gamma
Radium D (Radio-lead) ↓	40 years	rayless	Thorium D ↓ ?	?	
Radium E ↓	6 days	rayless	Actinium ↓	?	rayless
Radium F ↓	4.5 days	beta and gamma	Radioactinium ↓	19.5 days	alpha
Radium G (Polonium) ↓ ?	140 days	alpha	Actinium X ↓	10 days	alpha
			Emanation ↓	3.7 seconds	alpha
			Actinium A ↓	36 minutes	beta
			Actinium B ↓	2.15 minutes	alpha
			Actinium C ↓ ?	5.1 minutes	beta and gamma

*From McClung's *Conduction of Electricity through Gases and Radioactivity*, copyright by P. Blakiston's Son & Co., Philadelphia, 1909.

As the life of the radioactive elements, by reason of disintegration, is comparatively short, they must be in process of formation as well as disintegration. Two views are possible. They may be formed by the disintegration of more complex elements, as radium, for example, is formed from uranium. On this theory matter is first complex and gradually becomes simpler and less active. The parents of the heaviest radioactive elements may already have disappeared from the earth or from the universe. Another theory is the reverse of this. Primordial chaos may be conceived as filled with ions, in positive and negative pairs. From these, more and more complex atoms have been evolved, through the action of various known forces. All atoms simpler than hydrogen have already entered more elaborate combinations. It seems probable that both processes are going on, simultaneously. The examples of transmutation of elements through integration, given by the studies of Ramsay, Collie and Patterson, are not yet entirely satisfactory.

In radioactivity, electrons reach a very much higher velocity than in other known processes. The measurement of this velocity has led to results of the greatest importance. Kaufmann's experiments showed conclusively that, when the electron approaches the velocity of light, its mass increases rapidly. He found the mass of a swiftly-moving particle to be about three times that of one which was moving slowly. In a swiftly-moving electron about 3/4 of the apparent mass must be electro-magnetic, that is, due to its motion.

Any charged body, when in motion, sets up around itself a magnetic field, which tends, through what is known as self-induction, to retard the motion of the charged body. To these phenomena, or to changes in the æther which they represent, is due the principal mass of the swiftly-moving electron.

Has the electron any other mass? Is the apparent mass of the slowly-moving particle (about 1/1700 of the mass of the hydrogen atom) to be considered as electro-magnetic? Kaufmann says "Yes," and this view is accepted by most modern physicists. Mathematical calculations seem to show that the electron can have no "material" mass at all; that it is merely a point or region where a definite electric charge is concentrated.

What shall we say as to the positive ion, carrying an equivalent electrical charge, which represents most of the mass of the atom? Is its mass also electrical, or are we to postulate two kinds of mass, one "material," the other electro-magnetic? An experimental solution of this problem is thus far lacking, but many physicists are inclined to take the former view. What is called matter would then resolve itself into a form of energy, and a great step would be taken toward the unification of our physical knowledge. This is at least a legitimate hypothesis. It already appears to be a more successful hypothesis than that which considers the atom or the electron as "stuff."

Lorentz' cautious summary may be quoted. "What we want to know is, whether the mass of the positive electron can be calculated from the distribution of its charge in the same way as we can determine the mass of the negative particle. This remains, I believe, an open question, about which we shall do well to speak with some reserve. In a more general sense, I for one should be quite willing to adopt an electromagnetic theory of matter and of the forces between material particles. As regards matter, many arguments point to the conclusion that its ultimate particles always carry electric charges and that these are not merely accessory but very essential. We should introduce what seems to me an unnecessary dualism, if we considered these charges and what else there may be in the particles as wholly distinct from each other."*

It will be appropriate to close this chapter with the words with which Sir J. J. Thomson closes his article on *Matter* in the *Encyclopædia Britannica*. "We have confined our attention to the view that the constitution of matter is electrical; we have done so because this view is more closely in touch with experiment than any other yet advanced. The units of which matter is built up on this theory have been isolated and detected in the laboratory, and we may hope to discover more and more of their properties. By seeing whether the properties of matter are or are not such as would arise from a collection of units having these properties, we can apply to this theory tests of a much more definite and rigorous character than we can apply to any other theory of matter."†

* Electrons, p. 45. † *Enc. Brit.*, XVII, 895 b.

CHAPTER IV

IS THERE AN ÆTHER?

THERE has been some tendency in recent physics to transfer to the æther the functions formerly assigned to matter. Thus one of Thomson's statements of the electrical theory of matter is that "all mass is mass of the æther, all momentum, momentum of the æther, and all kinetic energy, kinetic energy of the æther."*

The idea of the æther as a substance filling all space not occupied by material bodies, began as a postulate of those who could not tolerate the notion of action across an empty distance. Clerk Maxwell's researches made it a legitimate hypothesis. Light, heat and electricity travel in waves, without loss, and occupy an appreciable time in their passage. Such waves seem to demand a medium that will serve as a bearer for the undulations.

The attempts to frame a constitution for the æther have not been particularly successful. The old elastic-solid idea and Lord Kelvin's theory of the vortex-ring have not met the demands made upon them, in spite of repeated revisions. There is little to recommend Mendelejeff's theory that the æther is the lightest

* *Electricity and Matter,* 1904, p. 51.

known element and a definite form of matter. Larmor's theory, somewhat similar to that of Maxwell, is that "an electron or unit charge of electricity is a center of intrinsic strain, probably of a gyrostatic type, in an æther, which is also the medium in which are propagated the waves of light and wireless telegraphy. . . . Electricity is a state of intrinsic strain in a universal medium. That medium is prior to matter, and therefore not necessarily expressible in terms of matter."*

Larmor's view, which is full of suggestion, was elaborated with great mathematical skill before the discoveries by Thomson and Kaufmann as to the mass of electrons. This mass, as we saw in our last chapter, is probably electrical. What does that mean? According to Thomson's view, referred to at the opening of this chapter, the inertia of any body is simply the mass of the æther surrounding it which is carried along by the lines of electrical force associated with the body. He has calculated the density of the æther attached to an electron as about 2,000 million times that of lead; Lodge has reached a similar figure. Such a density is conceivable "if we remember that in all probability matter is composed mainly of holes. We may, in fact, regard matter as possessing a bird-cage kind of structure in which the volume of the æther disturbed by the wires when the structure is moved is infinitesimal in comparison with the volume inclosed

* W. C. D. Whetham, *Recent Development of Physical Science,* 1904, p. 282, paraphrasing J. Larmor, *Æther and Matter,* 1900.

by them."* This idea gains some plausibility from the fact that light-waves are now known to exert a definite pressure; that is, undulations in the æther appear to have momentum, like undulations in water or air.

The question of a possible motion of this hypothetical æther may be approached along another line, a line that brings us to the principle of relativity, the establishment of which is one of the revolutionary events of recent physics.

We might say that the ordinary Newtonian mechanics is based on the following assumptions: first, three-dimensionate space; second, simultaneous moments of a continuous time; third, bodies whose mass is a constant, the product of their volume and density; fourth, forces acting between these bodies inversely as the square of their distance apart; fifth, a base line that can be used as a standard of reference in determining directions and distances; sixth, a medium through which forces can act, bodies move under the influence of forces, and energy be transmitted without friction or deflection due to the medium. (Static or potential energy is usually stated as the product of a force and the distance though which it acts, and kinetic energy as one-half the product of the mass and the square of the velocity.) These assumptions are not axioms but hypotheses; any one of them is open to challenge. We begin by doubting the third and sixth, and may end by doubting others also.

* J. J. Thomson, *Recent Progress in Physics,* Presidential Address at British Association Meeting, 1909. Reprinted in Smithsonian Report for 1909, pp. 185-205.

To quote from the excellent historical summary by Lewis and Tolman: "Until a few years ago every known fact about light, electricity and magnetism [in particular, the aberration of stellar light] was in agreement with the theory of a stationary medium or æther, pervading all space, but offering no resistance to the motion of ponderable matter. This theory of a stagnant æther led to the belief that the absolute velocity of the earth through this medium could be determined by optical and electrical measurements. Thus it was predicted that the time required for a beam of light to pass over a given distance, from a fixed point to a mirror and back, should be different in a path lying in the direction of the earth's motion and in a path lying at right angles to this line of motion. This prediction was tested in the crucial experiment of Michelson and Morley, who found, in spite of the extreme precision of their method, not the slightest difference in the different paths. It was also predicted from the æther theory that a charged condenser suspended by a wire would be subject to a torsional effect due to the earth's motion. But the absence of this effect was proved experimentally by Trouton and Noble."

While the phenomenon of aberration gave rise to the idea of light-waves left behind in the æther by the movement of the earth, these experiments seem to show that the earth is at rest, or practically so, with reference to the æther immediately surrounding it. Are we to conclude that the earth drags some of the æther with it in its orbital motion, as suggested by the previous experiments of Airy and Fizeau? An alternative hypothesis was offered some years ago by Lorentz, "who assumed that all bodies in motion are shortened in the line of their motion by an amount which is a simple function of the velocity. [A recent example is the apparent flattening of a swiftly-moving electron.] This shortening would produce a compensation just sufficient to offset the predicted positive effect in the Michelson-Morley experiment, and would also account for the result obtained by Trouton and Noble. . . .

"Einstein has gone one step farther. Because of the experiments that we have cited, and because of the failure of every other attempt that has ever been made to determine absolute velocity through space, he concludes that further similar attempts will also fail. In fact, he states as a law of nature that absolute uniform translatory motion can be neither measured nor detected."

To put this first postulate in another form, the only motion which has physical significance is the motion of one body or system of bodies relative to another. The æther cannot be regarded as a system in this sense. In Michelson and Morley's experiment, both the observer and the source of light are on the earth; hence there is no relative motion and no possibility of detecting motion at all. We have no means of determining whether the æther or any part of it is in motion or at rest. This seems to militate against Thomson's idea of electrical mass as due to the æther dragged along by the electron.

"The second fundamental generalization made by Einstein he calls 'the law of the constancy of light velocity.' It states that the velocity of light in free space appears the same to all observers, regardless of the motion of the source of light or of the observer. These two laws taken together constitute the principle of relativity. They generalize a number of experimental facts and are inconsistent with none."*

The second postulate of the relativity principle is, to some extent (what the first is wholly), a matter of optics or psychology. We might state it in this way: the only velocities which can be detected and measured are velocities relative to that of light. The reason for this is that, for practical purposes, we must *see* the beginning and end of the motion we are measuring and the beginning and end of the linear scale used in measurement. A velocity greater than that of light might produce sensible effects, but we should have no means of measuring it.

But the relativity of all velocities with reference to light cannot be considered as entirely psychological, since it enters into the determination of mass. Physicists are coming to recognize that the increase in the mass of an electron with the increase of velocity is not an exceptional case, but that the same thing is true of all mass. That means that we must surrender the Newtonian notion of mass as independent of velocity. In the non-Newtonian mechanics, which is now beginning to crystallize, mass is rather a function of the

* G. N. Lewis and R. C. Tolman, *The Principle of Relativity and Non-Newtonian Mechanics, Philosophical Mag.*, XVIII, 510 (1909.) References are given to the original papers.

velocity. Recently Bücherer has shown independently that the mass of a body increases in a definite proportion according to the ratio of its velocity to the velocity of light.* A body at rest would have no mass. Kinetic energy varies between $1/2\ mv^2$ at low velocity, the old Newtonian figure, and mv^2 at the velocity of light. The latter figure gives the kinetic energy of a beam of radiation, which is assumed to be due to a mass moving with the velocity of light.†

I shall return a little later to this hypothesis regarding the nature of light. At this point it is in order to remark that, if the hypothesis can be established, the idea of a beam of light as a series of waves in the æther proves untenable. Since the undulation of a beam of light was the sole ground for assuming an æther, we must reject the æther hypothesis. (The cause of the undulation is and always has been an independent problem.) Campbell, in a recent article, challenges any one to reconcile the idea of an æther with recent experiments as to the nature of light. "A demonstration that the case for the æther is ludicrously weak, where it was thought to be the strongest, that the concept has never been the source of anything but fallacy and confusion of thought, may serve to expedite its relegation to the dust-heap where now 'phlogiston' and 'caloric' are mouldering."‡ Even where the concept of

* The "rest" of large bodies is only apparent. Their component molecules and electrons are in rapid motion.

† G. N. Lewis, *Non-Newtonian Mechanics, Philos. Mag.*, XVI, 705 (1908).

‡ Norman Campbell, *The Principles of Dynamics, Philos. Mag.*, XIX, 190 (1910).

the æther is retained, there is a tendency to ignore it and talk about phenomena in a perfect vacuum.

The rejection of a physical æther means the rejection of the idea of infinity. Though a convenient mathematical fiction, "the infinite" has no basis in observation and experience. Physically speaking, there is no evidence that being extends beyond the boundaries of the universe at all, not to speak of an infinite distance. The stars cease after a certain distance, as was shown in our astronomical chapter. Nebulous particles may be assumed to do the same thing. And that is the end; there is no æther to carry the universe further.

Any reference to distance involves the question of measurement. Just at present we are house-cleaning in this department of our knowledge. The old Newtonian mechanics is likely to be consigned to the garret, for two reasons. It has never been able to secure a satisfactory base-line for its measurements. And we never could be sure that the units of measurement were constant, whether these were arbitrarily chosen, like the yard and pound, or based on such natural measures as the diameter of the earth at its equator, and the duration of its passage through daily revolution and yearly orbit. Still another objection to the old mechanics, as Planck suggests, is its anthropomorphism. Everything is observed and measured from the standpoint of a human observer.

The principle of relativity has given us a new constant, independent of conditions and of the motion or rest of the observer: the velocity of light in a vacuum.

From this the practical units of time and linear dimension may be derived. A second is the time occupied by the passage of light between two arbitrarily chosen points. A metre or yard is the distance traversed by light between other points selected.

The use of units is suggested by the fact that the universe is made up of parts. Of any one of these natural units we may form an objectively valid concept, as we saw in our first chapter, a concept concretely derived and concretely applicable. An electron is a real "thing," whether we conceive of it as a charged particle, or merely as a center of force. So the atom is a real thing; the particles or electric charges composing it are related to one another in such a way that it can be sharply distinguished from the group which forms a neighboring atom. So with a molecule, a star, an atmosphere. The philosophical term "category" is a convenient abstraction to use here. We may conceive of the universe not only under the broad category of being and under the category of unity, but under the category of number. Not only does the universe exist, not only is it dynamically one, but it is made up of units which may, at least temporarily, be distinguished and characterized.

Since space and time can be measured, since even such a simple conception as the foregoing involves the idea of units changing from one time to another, the question inevitably arises: "What are space and time?" The Newtonian idea of a space and time "in which" things happened was full of difficulty from every point of view. Nowhere were the *a priori* philosophers required to display such feats of verbal jugglery. Must these last remaining assumptions of the Newtonian mechanics go the way of all the rest? Undoubtedly. This has been clearly seen by Minkowski, Planck, and other physicists. As Campbell says: "It is the great merit of the Principle of Relativity that it forces on our attention the true nature of the concepts of 'real time' and 'real space' which have caused such endless confusion. If we mean by them quantities which are directly observed to be the same by all observers, there simply is no real space and real time. If we mean by them, as apparently we do mean nowadays, functions of the directly observed quantities which are the same for all observers, then they are derivative conceptions which depend for their meaning on the acceptance of some theory as to how the directly observed quantities will vary with the motion, position, etc., of the observers."*

My own putting of the case is as follows. I have already given a brief analysis of the concept "space,"† showing it to be derived from the facts of the objective world. The concept is merely a convenient abstraction; what do the spacial facts of the universe give us? Merely measurable relations. Given two units, two electric charges we will say, and relation begins. Since light may pass between them, we can measure the varying distance apart of these two cen-

* Norman Campbell, *Common Sense of Relativity, Philos. Mag.*, XXI, 514 (1911).

† See *ante*, p. 12 *f*.

ters of force. Given three charges and we have bi-mensurate relation. That is, we can measure the distance from one center of force to each of the other two: from *a* to *b* and *c*, from *b* to *a* and *c*, from *c* to *a* and *b*. Given four charges and we have tri-mensurate relation; we can measure from a center of force to each of the other three. And that is space. It is hard to give any better definition of it. The conception is comparatively simple, if we once free our minds from the ideas inculcated by the old mechanics and geometry. The universe, from one point of view, is simply the tri-mensurate relation of our four charges immensely expanded. It is made up of certain units and these stand in certain changing, but at any point of change measurable, relations, each unit related to all the others. Where stars and nebulous particles cease, there relations cease, and what we know as space ceases.

We might make a somewhat similar analysis of the concept "time," showing how it is derived from the facts of the external world. The temporal facts of the universe give us measurable sequences. Something happens to a unit. A planet passes through a certain orbit around a central sun. Its relation to this sun and to other planets and suns is constantly changing; changes of relation succeed each other incessantly. All the units of the universe are changing their relations in this way. Between this set of relations and that set of relations the passage of light would occupy a certain period which we are accustomed to call a second. And these sequences of change throughout the universe, which theoretically, because of the inter-relation of the units, could all be included in one act of measurement, constitute what we commonly speak of as time. At the boundaries of the universe, time ceases. Where there are no movements there are no sequences and there is no time. We have merely added to our list of physical categories the convenient abstractions of sequence and spacial relation.

One question which is likely to be raised by this conclusion is that of the conservation of energy. When the light and heat of the stars reaches the boundary of the universe, what becomes of the energy involved? This applies particularly to the stars farthest out. Are we to suppose that energy simply dies away as it approaches the boundary of the universe? This would mean the gradual, though extremely slow, dissipation of energy.

A number of answers might be given to this question. We could accept without great difficulty the fact of dissipation, since it is only an inference that the conservation of energy applies to the universe as a whole. On the other hand, in the non-Newtonian mechanics the universe has limits, but not boundaries in the sense of energy-traps. Again, it is perfectly conceivable that radiant energy exists only between bodies, as is the case with the energy due to gravitation. In such case, the farthest stars would radiate energy only to other stars. The difficulties are equally great on any other theory of space or of the extent of the universe.

CHAPTER V

THE UNIVERSAL ENERGY

OUR discussions of matter and æther have led us to the study of energy, as to the heart of physics. Force and energy are the dominant facts in the physical universe. But it is by no means easy to win one's way through the present confusion. This is due partly to the apparent break-down of the Newtonian mechanics and partly to the fact that the recent discoveries in electricity and light have not yet become clarified and crystallized into scientific dogma. We may begin by asking what are the various forms of *force* actually observed by the physical sciences. What do we know about them, without reference to the old definitions and classifications?

A. First of all, there is the force of *electrical attraction* or repulsion, represented by the electric charge. This charge may be either negative or positive. The former is known to us as the electron; the latter is an equivalent unit whose real nature is not yet understood. The electric charge, either negative or paired with a positive, is probably to be regarded as the unit of the atom, and so of all matter.

B. The force of *magnetic attraction* or repulsion, set up by the motion of an electron (or of any moving body.)

C. The *pressure of radiation,* exerted by a beam of light. The fact of such pressure is clear enough from recent studies, but the explanation of it is still in some doubt. Planck's investigations seem to lead to a revival of the emission theory of light, in a modified form. Certain units are sent out through space—normally in straight lines, with an undulatory motion and a linear velocity in a vacuum of 3×10^{10} cm. per second—and exert a definite pressure on striking any body in their path. A series of such "quantities" following the same path would represent a light wave.

D. *Molecular attraction.* The molecules of any body have a force of attraction for each other, varying in strength for different substances. This is generally known as "cohesion," and determines such properties of matter as tenacity, ductility, lower or higher melting-point, etc. There is also a certain force, termed "adhesion," between the molecules of adjacent bodies. These molecular forces appear to act only through a short distance, estimated at less than 1/200,000 of a centimetre.* They may be electrical in character; some suggestive theories of this have been put forward.†

E. *Gravitation.* All bodies, from single molecules (possibly even electrons) to large aggregations of molecules, attract one another, with a force varying directly as the product of their masses and inversely as the

* A. Wilmer Duff, *Text Book of Physics,* 1909, pp. 115, 146.

† See articles by Wm. L. Sutherland, *Philos. Mag.,* XVII, 657; XX, 249. *Cf.* Lodge, *Electrons,* 155 *ff.*

square of their distances apart. The force of gravitation is unique, in that it appears to be independent of physical conditions and uninfluenced by the action of other forces. It also appears to act instantaneously; otherwise the orbit of a planet would be a spiral, not a closed curve.

Before generalizing from this list of forces, and as a partial basis for generalization, it will be well for us to make a corresponding list of the forms of kinetic energy now known to science. Force is best understood through the work it does.

1. *Electrical energy,* represented by the motion of the electric charge, either positive or negative, this motion being due to the attraction or repulsion of other charges or to the action of a magnetic field. The motion is in open curves, oscillations or closed orbits. The amount of kinetic energy varies from $1/2\ mv^2$ to mv^2, according to the velocity. The transfer of electrons constitutes what is known as an electric current, and the strength of the current, as we have seen, is proportional to the number of electrons transferred in unit time. To this transfer of electrons is probably due also the phenomenon of chemical affinity and combination. A certain amount of external energy (usually "heat") must be applied before electrons can be detached from certain atoms and attach themselves to others, giving the two sets of atoms chemical affinity. The same is true of the break-up of a chemical compound. If this general theory is correct, chemical energy is but another name for electrical energy.

2. The energy of a *magnetic field,* due to the kinetic energy of an electron or other body, in steady motion. It dies away as the motion of the exciting body ceases. As a result we have the apparent inertia and mass of the electron, or of any moving body. Magnetic energy may in turn be transferred by induction to a new body that comes within range.

3. *Radiation.* The kinetic energy of a beam of light is equal to the product of the mass of the light-unit and the square of the velocity. On Planck's theory, as I understand it, the mass would vary for different wave-lengths, the shorter waves representing the greater accumulation of energy.*

On reaching another body, part of the radiant energy in a wave is lost through collision, resulting either in ionization or in the development of heat. The remainder is transferred to electrons or atoms in the path of the ray which have the same natural periods of vibration.

4. *Molecular energy.* Strictly speaking, this is the energy due to molecular attraction (D) in the form of friction, osmotic pressure, etc. Since this form of energy is known to us chiefly through its interchange

* The longest waves known are those discovered by Hertz a few years ago and made use of in wireless telegraphy. The shortest "electric" waves discovered are about four-tenths of a millimetre in length. Heat waves come next in the series (the longest measured are about .06 mm.) These merge into the shorter light waves, which vary in length for the different rays within and without the visible spectrum. (Red waves, .00075 mm.; violet, .00038 mm.; shortest waves investigated, .0001.) Röntgen rays come still lower in the series.

with heat, it will be convenient to consider under this head the energy of *molecular motion*. Molecules, like electrons, are in constant motion. They may occasionally collide with each other, and in that case change velocities with each collision. The mean velocity of the molecules in a given volume is the same under the same conditions.

5. What might be termed *molar energy*. Bodies larger than molecules, under the influence of gravitation, show a form of kinetic energy which it is convenient to distinguish from 4 (though the two may be partly or wholly identical). As in the previous forms of energy, "natural" motion of the body in a straight line is always modified by the attraction of other bodies. It may become revolution in an orbit or rotation on an axis. At the moderate velocities to which all bodies larger than electrons or light-units appear to be limited, this form of kinetic energy may be stated as $1/2\ mv^2$.

Of the forces enumerated, the electrical and magnetic appear to be equivalent and interchangeable. It is probably safe to include in this equivalence, under certain conditions, the force represented by radiation; also to assume that molecular attraction may be explained electrically. The five forces known to us would thus resolve themselves into two: an electrical and a gravitational.

That all forces are ultimately equivalent is suggested by the fact that the various forms of kinetic energy to which they give rise are, under proper con-

CHART SHOWING CONVERSION OF THE VARIOUS FORMS OF KINETIC ENERGY WITH EXAMPLES

Direction of conversion is from left to right

	1. ELECTRICAL	2. MAGNETIC	3. RADIANT	4. MOLECULAR	5. MOLAR
I. ELECTRICAL (of an electric charge)	By collision (ionization); and by way of II (electro-magnetic induction).	By direct conversion, a magnetic field being produced by a moving charge.	By sudden and irregular starting or stopping of electrons (Röntgen rays); and by periodic motion of electrons (light waves, etc.).	By collision (heat developed in ionization, in passage of current thro' a wire, and in chemical change).	By motion of charged bodies.
II. MAGNETIC (of a magnetic field)	Electro-magnetic induction; self-induction.	Magnetic induction.	Zeeman effect.	Heat due to hysteresis, etc.	By motion of two magnets (electric motor).
III. RADIANT ("æther" waves and pulses)	Photo-electric effects.	(See under electrical, III-1.)	Fluorescence and phosphorescence.	Absorption of sun's rays; generation of heat by collision.	Motion of bodies under the influence of light pressure.
IV. MOLECULAR (including atomic)	By collision (ionization, bringing about chemical affinity).	Magnetization of a mass of molten iron, nickel, etc., by lowering of temperature.	By periodic motion of atoms (band spectra); also by way of 1.	By collision (transfer of heat by conduction); and by vibration (sound waves).	By expansion, as in steam or gas engine, attended by fall in temperature, and producing motion of mass.
V. MOLAR (involving masses larger than molecules)	Development of an electric charge on a body through induction or friction.	By electric dynamo.	By impact of large masses, generating heat and light waves (bodies becoming incandescent).	By pressure and impact, producing heat.	By collision and thro' proper machines (heat lost in process).

ditions, inter-convertible. I have tried to bring out this fact in the accompanying table showing the conversion of one form of energy into another. The transformations are not necessarily reversible. But the same units and the same mathematical equations may be employed for all the forms of kinetic energy given in the table. And by including potential energy (force multiplied by the distance through which it acts) the various forms of energy prove to be exact equivalents.

This generalization is commonly known as the law of the conservation of energy. Assuming that the universe is a closed system, the law holds good. The energy in the physical universe is changing its forms but not its total quantity.

The idea was put forward, notably by Professor Gibbs and Lord Kelvin, that the availability of this energy is constantly diminishing, through its transformation into uniformly-diffused heat. This is undoubtedly true in certain parts of the universe; is it true of the universe as a whole? It is too early to attempt an answer to this question. In practice, the stellar systems seem to be speeding up as well as running down. A star appears to pass through a definite cycle—starting as a nebula, condensing into a hot star, cooling off through radiation, and finally, through collision or explosion, being resolved again into a nebula. Any loss of availability must be extremely slow. If there are exceptions to the second law of energetics, they are to be looked for in the electrical field. The chief fund of energy in the universe is not heat, but the kinetic energy of electrons. The radioactive elements, for example, are in process of formation as well as decomposition. The same is probably true of all the heavier atoms, at a temperature near that of the sun. In this process of transmutation, is the energy of the elements becoming less available?

On the relativity principle, motion is simply the change of relation of bodies. This change of relation is associated with the force or forces connecting the bodies. What is a force? We do not know. How does force initiate motion—cause changes of relation? The physical sciences give us no answer. Even the facts represented by the word "cause" are obscure. A unit —an electron for example—passing through certain changes of relation, affects in some way the changes of another unit; similar antecedents of change are apparently connected with similar consequents. But this is merely a statement of familiar facts, not an explanation of them. "Cause", for the physical sciences, simply means, what we have already stated, that the universe is dynamically one.

The new physics gave us the hypothesis, which further study seems likely to confirm, that the charged particle is the unit of the atom, and further that this charged particle is not material but merely a center of force. Mass is coming to be thought of as a function of velocity. Philosophically, therefore, matter is identical with energy, and the conservation of matter is the conservation of energy. And by energy, to analyze the concept, we mean in general the sum of the various forms of energy which are found to be operative. More particularly, assuming that the electron or the electrical doublet will prove to be the unit even of gravitation, we mean by energy the centers of force which, in their totality, with their accompanying motions, make up the physical universe. As far as our knowledge goes, there are always the same number of centers of electrical force, and their character remains constant through all sequences and changes of relation.

Force plus motion,* or energy, or the physical universe (for the three terms are practically interchangeable) appears to be in some measure self-perpetuating and so self-explanatory. Given the proper number of unit electric doublets, their evolution and perpetuation as a universe is easily conceivable. Our minds naturally revert to the words of Herbert Spencer in one of his later essays, words prophetic in a way of the position taken by modern physics, words suggestive and yet tantalizing in their vagueness: "Amid the mysteries which become the more mysterious the more they are thought about, there will remain the one absolute certainty, that man is ever in presence of an Infinite and Eternal Energy, from which all things proceed."†

What do we know about this energy? Of its infinity we have no evidence; this term we have seen to be,

* If the hypothesis of an æther proved to be necessary, we must add it to this sum as an unknown quantity. The same would be true of a hypothetical matter, as a substratum for the electron.

† *Religious Retrospect and Prospect, Pop. Science Monthly,* XXIV, 351 (1884).

for philosophy, an unjustifiable abstraction, a sea-serpent drawn on the edge of the map to conceal our ignorance. Its eternity is not much more definite. Whether the universe is constantly renewing itself or whether its total energy is slowly but steadily becoming less available is still an unsettled question. How did this energy begin, or has it always been as it is today? We do not know. We have not even the basis for a guess.

Energy is one manifestation of being. Perhaps it is the sole manifestation; perhaps not—we cannot tell until we have explored other spheres of reality besides the physical. The most important question before us is whether, on the basis of the physical evidence, it is proper for us to speak of energy as having intelligence. The idea of unity carries with it the idea of uniformity. Throughout the universe, units of the same class are similar. One electron, as far as we can tell, is exactly like another; it has the same charge, the same apparent diameter and mass under the same conditions. So with atoms of any given composition, and with still more complex units. Similar units everywhere change in similar ways. There appears to be perfect uniformity in the way they affect and are affected by one another. It is this uniformity of nature which has enabled us to make the generalizations known as physical and chemical laws. These laws are unvarying. They have not changed in the millions of years during which we have been able to trace the history of the universe. They enable us, in many cases, to predict the future with the utmost confidence. They are, of course, our own abstractions. They may, however, be taken as fairly representing the customary relations and sequences of the universal energy.

What conclusion may we draw from the fact that it is possible for us to generalize from the natural world—that we are able to frame physical laws and categories? Simply this, that nature is uniform, which means that we are back where we started. The further conclusion might be drawn that it requires intelligence for any one to generalize. But to conclude the intelligence of the universe from our power intelligently to comprehend the universe is to read things backward. We must keep before us the facts of comparative psychology brought out in our first chapter.* "Mind" may have a philosophic value, beyond our present sphere, the physical. But our human intelligence has developed in adjustment to this physical universe, which is the chief field of its activity. Our minds, like the minds of animals, are tuned to the universe, not the universe to our minds.

Another side of the question of intelligence must be considered. Is there evidence of plan and purpose in the universe? Taking such facts as crystallization and mutual gravitation and the evolution of the stars, may we consider them as showing conformity to ideas, or to ideal ends? To our ideas, yes. We have studied and experimented and generalized. But to the ideas of an intelligent energy, no. The physical universe may

* See *ante,* p. 12.

be considered as manifesting intelligence in its processes; it may just as easily be conceived as merely automatic. And when we reach such a Kantian antimony, where exactly opposite conclusions may be drawn with equal reason, we may be sure that we have gone beyond the limits of sound inductive thinking and entered the *a priori.* We cannot even say that the universal energy is not an automaton, or a god. Our thought is impinging against the barrier of the physically unknowable. Natural theology may be theological but it is not natural.

It must be confessed that the contribution of the physical sciences, taken by themselves, is extremely meagre. With all the wonderful increase in our knowledge of physical facts, we know but little more about the interpretation of these facts than our fathers. The scientists of the last generation, who, flushed with recent victories, expected their physical laws to explain all the facts of existence, were doomed to disillusion. Physical laws have explained very little for us. The scientists of the present generation are more humble. They are content with increasing our store of knowledge in the physical group, gathering new inscriptions, as it were, while they wait for some Rosetta stone to give the clue to their decipherment.

Let us turn to the organic group of phenomena for such contribution as it has to make to the solution of the riddle of existence.

PART II

THE ORGANIC

CHAPTER VI

THE EVOLUTION OF LIFE

AT a certain period in the earth's history we find the beginning of a new group of phenomena, the organic. From the standpoint of physics, the appearance of life on this planet is a supernatural event. It is an exception to the physical, which hitherto has been the natural. Organisms, while to a certain extent following physical and chemical laws, are not apparently to be explained by these. A new science of biology arises, with its own laws and categories.

With the source of "life", unknown before this period, biology is not concerned. It examines, however, in connection with geology, the conditions under which life first made its appearance.

I have postponed to this point any reference to the physical history of the earth. Our idea of the first stages of geology will depend on whether we hold the theory of the earth as a molten body that has cooled off, or as a body that has grown to its present size through the aggregation of meteorites. Fortunately the decision of this question is not of great practical importance. The two theories come together in the Archeozoic Era. To this belong the earliest known rocks, chiefly igneous, which are thought to be universal and come to the surface on perhaps one-fifth of our present land area.

General Table of Geologic Time Divisions

Following Chamberlin and Salisbury, *Geology,* vol. II, p. 160.

Cenozoic
- Present
- Pleistocene—Quaternary
- Pliocene, Miocene, Oligocene, Eocene } Tertiary
- Transition (Arapahoe and Denver)

Mesozoic
- Upper Cretaceous
- Lower Cretaceous (Comanche or Shastan)
- Jurassic
- Triassic

Paleozoic
- Permian
- Coal Measures, or Pennsylvanian
- Subcarboniferous, or Mississippian
- Devonian
- Silurian
- Ordovician
- Cambrian

Great Unconformity

Proterozoic
- Keweenawan
- Unconformity
- Animikean (Upper Huronian)
- Unconformity
- Huronian

Great Unconformity

Archeozoic—Archean Complex
- Great Granitoid Series (Intrusive in the main, Laurentian)
- Great Schist Series (Mona, Kitchi, Keewatin, Quinnissec; Lower Huronian of some authors)

As to the age of the earth, the subject is in such an unsatisfactory state at present that I shall dismiss it with a brief notice. Lord Kelvin's argument from the cooling of the earth and other physical data gave four hundred million years as the maximum for geologic time and twenty million as the minimum. He later reduced his maximum to one hundred million, and still later stated that the time was "more than 29 and less than 40 million years and probably much nearer 20 than 40." The discovery of radioactivity has entirely vitiated this argument. Rutherford states that if the total mass of the earth contains as much radium as does ordinary clay, which yields an appreciable radioactive emanation, the present temperature of the earth might be maintained by this cause alone. Positive data may soon be furnished by the length of time required for helium to accumulate in various rocks; this method is due to R. J. Strutt. He finds one specimen of thorianite to be at least two hundred and eighty million years old. G. H. Darwin's argument from tidal action gives fifty-four million years as the minimum period since the separation of the moon from the earth, and two hundred million as the maximum, though he occasionally stretches the maximum to five hundred or 1,000 million.*

The arguments from erosion and the thickness of strata are equally unsatisfactory. When checked, however, by paleontology, they give us the order of the

* *Enc. Brit.,* art. *Geology,* vol. II, 650 d; *cf.* Darwin's article on *Tides,* XXVI, 960 d.

geological periods and some approximation to their comparative lengths. As a provisional schedule we may take C. D. Walcott's revision of Dana's figures: Paleozoic era 17,500,000 years, Mesozoic 7,240,000, Cenozoic 2,900,000.*

The presence of life during the Archeozoic Era has been inferred: First, from the presence of certain rocks, such as carbonaceous shales and limestones, which are usually the products of organic action. Second, the fossil remains found in the rocks of a later era show such a high development that it is necessary to assume a long previous evolution. Third, the conditions necessary for life seem to have been fulfilled. The earth during the Archeozoic Era was of sufficient mass to retain the lighter molecules which make up an atmosphere and a hydrosphere, a property which the moon (about one-eightieth of the earth) lacks, and Mars (about one-tenth of the earth) has only to a limited extent. The temperature of the earth's surface is supposed to have been below 100 C., a heat which is destructive to all known life, and yet well above zero. Although many forms of life will persist through any degree of cold, a certain mildness of temperature is necessary for their development.

In the later eras the rocks have been constantly less igneous and more sedimentary. Fossil remains begin to appear in the sedimentary rocks of the next, or Proterozoic, Era (to adopt the new terminology).

* *Proc. Am. Ass. Adv. Sci.*, XLII, 129-169 (1893); see discussion in H. S. Williams, *Geological Biology*, 1895, Chap. III.

The depth of these rocks shows an enormous stretch of time, and their formations indicate several radical alterations of the earth's surface. With the Cambrian Period of the Paleozoic Era we come on abundant fossils. The sea as it advanced again over the land surface was full of life, and shells and other remains were deposited in the sediment. Plant forms are necessarily absent from these deposits, but all branches of the animal kingdom are represented except the vertebrate. From this time onward the record is fairly complete. It is now customary to assign a very much greater value to the pre-Cambrian evolution than to the evolution which has taken place since the beginning of the Cambrian Period.

From the study of fossils, in connection with a study of existing species, it is possible to put together a history of the evolution of living forms on the earth, in spite of the many which have completely disappeared or are not yet discovered. Embryology comes to our assistance, for the embryos of most animals pass through stages resembling the embryonic stages of their ancestors. We also learn much from reversions and survivals of earlier characters.

The simplest forms of life today, which very probably are degenerate, are the "monera," usually classed with the animal kingdom. They are merely drops of protoplasm, and were at first thought to be without nucleus or organization of any sort, though nuclear material is now known to be distributed in the form of granules. They are capable of motion, of securing and digesting other protoplasm for food, and of reproducing themselves—sometimes by simple division, sometimes by the formation of spores. The cell as a whole is sensitive to stimuli and able to contract or relax.

The earliest forms of the plant kingdom, some of the so-called algae, are very similar, except that they have a distinct nucleus and are provided with plastids. Some of them move about in water like the monera; some cling to rocks or other organisms. They reproduce both by division and by spores. From this point, plant organisms continue to grow in complexity until we reach the elaborate flora of the coal-forming and later periods. Their evolution presents many similarities to that of animals: such as the colonies of cells among early forms, the organization of tissues and organs, the rise of sexual reproduction, etc. We see the decline and extinction of many forms, and the rise of improved forms, like the plants with protected seeds in the Cretaceous Period. Plants early lose their power of free motion. What most distinguishes them from animals is the fact that assimilation goes on, for the most part, all over the organism instead of in special organs. Except for some low forms, plants feed on particles of inorganic matter; while animals live on organic. Bergson has called attention to the fact that the plant, securing its food directly from mineral substances, is able to dispense with movement, and wraps itself in a hard membrane, which prevents external stimulation, feeling, and the development of consciousness.

Returning to the evolution of the animal kingdom, we find in the next class of the protozoa the rhizopods, which have definite nuclei. The amœba is perhaps the best known example. It puts out temporary feet. Its food, after being engulfed, circulates in the form of granules. Some of the rhizopods are naked; some are covered with a sort of shell. Other classes of protozoa have rudimentary organs, such as the flagellating feelers or cilia of the infusoria. Some of them form colonies made up of as many as 10,000 individuals.

There is a wide gap between the highest protozoa and the lowest metazoa, or many-called animals. In these the egg, by repeated subdivision, produces an ectoderm, or outer layer of cells, and an endoderm or inner layer. Between these there appears, in some cases, a mesoderm, in which future eggs develop. The cells, instead of being all of one type, are now differentiated to a certain extent so as to perform different functions.

It is impossible for us to take up, except in the most general way, the later stages of animal evolution. The greater the number of species which come to light, the greater the difficulty of naming and classifying, of tracing relationships and constructing family trees. Among the simpler metazoa, we find three groups of species: the sponges; the cœlentera, simple aquatic animals such as the hydras and sea-anemones, but including also the more highly-organized medusæ; and the vermes or worms. The latter represent a generalized type that appears in many forms: three layers of cells, an intestinal canal, a symmetrical body with a well-marked head and tail and upside and downside, and a nervous system ending in a frontal ganglion or brain. In the higher worms, or annelids, of which the common earthworm is a somewhat specialized but still typical example, the body is divided into a number of segments. Some species, like the brachiopods, are protected by a shell and may have a rudimentary heart and sense organs.

These three branches of the metazoa are apparently parallel. The embryo in each usually passes through a stage in which it resembles the simpler forms of protozoa. Both the developing embryos and some simple living forms tend to bridge the gap between protozoa and metazoa. All later branches are probably descended from the worms, though the evidence is not always clear.

The echinoderms, such as the starfish, need not detain us. The molluscs are a specialized and widely-distributed group. Besides the common shell-fish, we have the snail-like forms and the cephalopods. The latter, represented by the squid and the octopus, appear in the Ordovician Period. They have arms coming out from the head, a rudimentary brain-box, and highly-developed eyes. Well-protected, highly-organized and very powerful, the cephalopods dominated the waters of that day.

The arthropods are an immense group comprising more than 200,000 species, or more than half the animal species known. They include such divergent types as crustaceans, centipedes, insects and scorpions. Their common characteristics are jointed jaws, legs and bodies, symmetrical structure and hard skin. A large proportion of them are organized for life on land. The joint represents a great advance in structure. Arthropods often reach a high organic and nervous development, as in the famous trilobites of the geological middle ages, the lobsters and crabs, the spiders, the bees and the ants.

Between the worms and the vertebrates it is now customary to place several transitional types, such as the tunicates and the amphyoxus. Though more or less degenerate, they are considered to be descended from an ancestor closely related to the ancestor of the vertebrates. The noto-chord or axial rod is of cartilage rather than bone, but over this (in the tunicates) lies a rudimentary nervous system, ending in a brain and brain-eye, and the heart periodically reverses the blood-current.

In the vertebrates proper we reach the most successful experiments in organism and the highest animal forms. The embryo passes through a long series of changes, beginning as a simple "protozoic" cell, which repeatedly subdivides, passing through a worm-like stage. The three layers of cells develop into three sets of organs: the ectoderm into outer skin, sense organs and nervous system; the endoderm into stomach, intestines, lungs, etc.; the mesoderm into inner skin, muscles, connective tissue, bony skeleton and organs of reproduction.

The vertebrates appear late in history, the earliest specimens being low fish forms. The elasmobranchs, an order of fish with skeletons of cartilage instead of bone (still represented by the sharks and skates), first appear in force at the end of the Silurian Period. In the closing years of the Paleozoic Era these reach a remarkable development, especially along the line of size and attacking power. They are succeeded by the armored fish, and these in turn by the modern bony type. One very old order, the dipnoi or mud-fish, are provided with lungs and some other transitional features.

In the amphibians or batrachians, undoubtedly derived from some primitive fish form, fully developed lungs are present and the gills tend to be lost; the limbs end in fingers in place of fins; the heart has three chambers instead of two. Both amphibians and dipnoid fish are found in the closing periods of the Paleozoic Era. The changes in the earth's surface with which the era closed—the spread of glaciers and of arid regions—destroyed many of the existing species in the various branches. For this very reason the period was one favorable to the production of new forms. The reptiles diverge from the amphibian type. They are essentially land animals.

The Mesozoic Era has been termed the Age of Reptiles. The saurians and other strange monsters apparently ruled both land and sea. Some of these were winged and represent the earliest bird type. Birds are undoubtedly descended from some Mesozoic reptile.

They are highly organized and very active. Birds, like mammals, are warm-blooded, with a rapid circulation of oxygen, and show a high mental development; eye and ear organs are perfected.

Mammals of some sort also appear quite early but their evolution from reptiles has followed an entirely different line. Practically all mammals have the class features—hair-covering, sweat and fat glands, brain with four optic lobes ("corpora quadrigemina"), diaphragm separating heart and lungs from the abdominal cavity, and heart with a single left aortic arch. The hemispheres of the upper brain are of increased size. Many parts of the mammalian skeleton are also distinctive. The normal type has four limbs, twenty toes and forty-four teeth. Almost all are gregarious. The young when born are fed by the mother from milk specially secreted.

The earliest type of mammals, the monotremes, which begin to appear in the Triassic Period of the Mesozoic Era, closely resemble certain types of extinct reptiles (cynodontia). They lay eggs, like most of the lower animals. The young are nourished by means of a temporary pocket (which answers the purpose of teats), and glands which resemble sweat-glands. All higher mammals are now generally classed as eutheria, distinguished by teats, and milk-glands which appear to be specialized fat-glands. They undoubtedly go back to the Jurassic Period, though fossil remains are rare. The marsupials, once thought to be the ancestors of the other eutheria, are now recognized as a very old side-line, highly specialized and in some ways degenerate; the young are born alive after a short period of gestation and carried in a pouch by the mother.

The Cenozoic or Modern Era opens with the disappearance of the great saurian reptiles, and the entrance of the placental mammals. This revolution corresponds to the rise of plants with protected seeds at a slightly earlier period. With such a food supply the evolution of the placentals from the small generalized type was very rapid. The placenta for nourishing the embryo enabled them to maintain it in the womb for a longer period, varying roughly according to the bulk of the animal (three weeks in hares, forty weeks in the cow and in man, and ninety weeks in the elephant). The state of development at birth varies with different types, helplessness and so a lengthened period of infancy being common among the carnivora and others which are able to defend their young. All the sense organs are perfected. The cerebellum, greatly increased in size, is formed of a central lobe and two side lobes. The cerebral hemispheres tend to cover the lower regions of the brain, and their surface, with few exceptions, is convoluted instead of smooth. The size and complexity of the brain are proportioned to the bulk as well as to the intelligence of the species.

The ancestral lines of the placentals are still in some doubt. The original type of the upper Cretaceous Period, related to the ancestors of the monotremes and marsupials, was probably a small creature, living partly in trees, equipped with a snout and subsisting on insects, fruit, or whatever food came in its way. From this type the lemurs of the Eocene Period are supposed to be derived.* These are undoubtedly the ancestors of the true apes, which appear in the Miocene. They are generally classed together as primates. Comparing existing primates which may be considered as somewhat representative, such as the sloths, the lemurs, and the various anthropoidea, we notice a constant increase in intelligence, registered by the development of the brain and the increasing size and prominence of the head. There is also a tendency for the front feet to change into hands, and later still for the body to become vertical. There is an increasing prolongation of infancy. Mammalian development as a whole reaches its climax in the Eocene and Miocene Periods; the later periods show a decline in most of the orders.

A hasty and imperfect sketch like the foregoing can give but a little idea of the evolution of fauna from one period to another, the fossils in many cases showing unquestionably that the forms of one period or subdivision of a period were the ancestors of divergent forms in the next. The general hypothesis of evolution oi descent may be considered as established. The total number of distinct (Linnæan) "species" of animals and plants now existing on the earth, if all were listed, would probably mount into the millions, and the existing species cannot be more than a small per cent of those which have become extinct. All classification is,

* See discussion and references in *The Orders of Mammals,* Wm. K. Gregory, *Bull. Am. Museum of Natural History,* XXVII (1910).

of course, conventional. In a sense, individuals alone exist. Species and even orders and branches, as these terms are ordinarily used, shade into each other. De Vries contends, and probably with reason, that the true unit is the variety, or "elementary species", whose limits can only be determined by pedigree culture, but which breeds true under all conditions and is distinguishable from its neighbors in almost all organs. Thus the common species *draba verna,* or whitlow grass, is composed of over two hundred elementary species. Distinct from these are the "retrograde varieties", which have lost some distinctive character of their ancestors, such as coloring, spines, etc.*

Reference should be made to the facts covered by the term "environment." Conditions surrounding organisms are both physical and social, and subject to changes of various sorts. To quote from Chamberlin and Salisbury, we must recognize: "(1) rather abrupt changes brought about by overwhelming invasions; (2) less abrupt changes brought about by the more gradual inflow of foreign species, and the gradual commingling of the immigrants with the resident species; (3) very gradual changes, or nearly constant states, due to the slow evolution of resident species when not much affected by immigration or by physical changes; and (4) more rapid evolution due to profound changes in the physical conditions or in other agencies affecting the life, including perhaps the unknown causes that may have brought about a mutating stage simulta-

* Hugo de Vries, *Species and Varieties,* Chicago, 1905, pp. 12, 152.

neously in large numbers of the leading species."* The greatest changes in fauna are those marking the close of eras and periods, but radical changes also occur within the periods. Thus there are three stages of life within the Cambrian: the lower, middle and upper. The Devonian shows five distinct faunas invading the continent of North America, partly in succession, partly simultaneously. Each commingled with the previous fauna, and their conflict resulted in the elimination of some species, the readjustment of others and the fusion of others.

A study of comparative anatomy would reveal a wide range of experimenting in nature. In order to survive, organisms must adapt themselves, generation after generation, to these varying physical and social conditions. But under this general law the development of organs in the different branches and classes is sometimes parallel, sometimes quite diverse. Even where the development is parallel, it is analogous rather than homologous or structural. Thus, four different types of wings have been developed, for the same purpose, by insects, reptiles, birds and mammals. The eye-organ shows a homologous development as far up as certain worms and their descendants. The original pigment spot, with a simple mechanism for breaking up the rays of light so as to distinguish light from darkness, becomes a mass of pigment cells covering a series of rods which end in a nerve, and to this in turn is added a projecting lens. But here the homology

* Chamberlin and Salisbury, *Geology*, II, 296.

ceases. The highly-developed eyes of the cuttlefish only superficially resemble those of a vertebrate. They lie on the outside of the head instead of being brain-eyes, the rods are turned toward the eye-opening rather than away from it, and there are other fundamental differences in structure.

Passing to the question of the origin of species, we speak a different language today from the science of a generation ago. A new era has been opened by the work of Batteson and de Vries. There is not yet the same unanimity as in the new physics, and all statements and conclusions are subject to change without notice. Variation now stands out as the most prominent factor in the evolution of species.

Darwin, and especially his successors the strict "Darwinians", put the emphasis upon minute differences in size, color, etc., and the evolution of species was conceived as a summation of such minute individual differences during a long period. That such variations exist is very evident; the resemblance of offspring and parent is never complete, even in parthenogenesis. These fluctuations have been studied in recent years by statistical methods. They are found to occur according to the law of chance, and there always tends to be retrogression toward the mean of the race. The more we know about fluctuations, the less it seems possible for species to originate in this way. The old "Darwinism" has been discarded by the majority of progressive scientists.*

* Detailed reasons are given in many works: e. g. Kellogg, *Darwinism Today,* 1907; T. H. Morgan, *Evolution and Adaptation,* 1903, an invaluable book.

On the other hand, increasing emphasis has been put on sudden, discontinuous variations, formerly known as "sports," and now generally termed "mutations." These may be large or small, do not follow the law of chance, are of rare occurrence (though in any given case the same or similar modifications are often exhibited by a number of individuals), display a new character or characters, and breed true. It is these mutations which give rise to "elementary species" without transitional links. A new position of organic equilibrium has been reached at a single bound. "When a mutation has occurred," says de Vries, "a new species is already in existence, and will remain in existence, unless all the progeny of the mutation are destroyed."

In the classical example, de Vries found an evening primrose in a new environment that seemed to be in a variable mood, producing seven distinct new species in a few years, the new individuals breeding true. In seven generations, from seeds of the original species, about 50,000 plants were obtained, of which about eight hundred were mutations, the seven new species claiming from one to three hundred and fifty each. There were a few other variants that were either inconstant or sterile. Each form differed from the others in a large number of particulars. Mutations occurred as freely in the wild forms as in those under cultivation.*

Some species of domesticated animals are known to

* *Species and Varieties*, p. 521 *ff.*

have arisen by mutation, and further study is increasing the number of plants where this is known to take place. Further examples are needed, and expected with some confidence. Probably the mutation theory may be considered to have won its way.

That mutations can avoid being swamped by cross-breeding and so give rise to new species is due to what is known as Mendel's law. When organisms of two distinct elementary species—for example, tall and dwarf varieties—are crossed, one character is likely to prove dominant, the other recessive. In the first generation, the progeny will all apparently be of the dominant type—that is, in this case, they will all be tall. If allowed to fertilize themselves, however, the two original types emerge again in the second generation, in the proportion of three dominants to one recessive, or three tall to one dwarf. The recessives and one-third of the dominants are pure—that is, they breed true in subsequent generations. The other dominants are in reality mixed, giving rise to the same proportion, three dominants to one recessive, and so on indefinitely. If one of the organisms—for example, the dwarf—is a mutation, the result is the establishment of a new elementary species. This is possible even in the case of a single mutation or sport which for some reason does not fertilize its own offspring, but crosses with the old type. We will suppose that the mutation and the old type have antagonistic characters. Experiment shows that the strain of the new character cannot be lost, as long as normal reproduction continues. A pure specimen of the new type is likely to appear in the third generation of offspring.

Since species usually differ in more than one character, the effects of crossing will generally be much more complicated than in the example given. Mendel's law has been strikingly confirmed with a considerable number of animals and plants. We may say further, in interpretation of the law, that hybrids act as they would if the germ-cells of each species contained a number of distinct and often antagonistic unit-characters, such as tallness and dwarfness, capable of being segregated, as in the germ-cells of the pure dominants and recessives, but not actually blended. The list of such unit-characters is still somewhat limited, and Mendel's law has not yet been extended successfully to man and to some of the higher domestic animals. In many species—for example, different races of men—crossing produces a blend, such as mulatto or quadroon, which breeds true in color, though probably following Mendel's law as to physiognomy.

Natural selection is now considered to be, what it was for Darwin himself, the mechanical weeding-out of organisms and species unadapted or less adapted than others to their environment. But this means that "the theory of natural selection has nothing to do with the *origin* of species, but with the survival of already formed species."* The factor of struggle was probably exaggerated by Darwin, and we now know that it is not absolutely necessary for a variation to be use-

* T. H. Morgan, *Pop. Science Monthly,* 64 (1905).

ful in order to survive. As Morgan says: "If we suppose that new mutations and 'definitely' inherited variations suddenly appear, some of which will find an environment to which they are more or less well fitted, we can see how evolution may have gone on without assuming new species have been formed through a process of competition. Nature's supreme test is survival. She makes new forms to bring them to this test through mutation, and does not remodel old forms through a process of individual selection."* All that is necessary is that organs showing mutation should be, as a whole, "sufficiently adapted to get a foothold."

The question of the origin of species is resolving itself into the question of the origin of mutations. No satisfactory answer has yet been given. Nägel's theory of a natural tendency in the organism toward progress must be looked on with suspicion. It is even doubtful whether there is any inherent tendency toward variation. Ordinary fluctuating variations seem to be due to slight differences in the life-history of the different germ-cells; it is possible that mutations merely represent more or greater differences in this life-history. There are many indications that mutations are connected with a change in the environment of the organism. The difficulty with this is that the origin of a mutation must be found in the germ-cell, and we as yet know of no way by which environment can definitely affect the germ-cell. Luther Burbank

* *Evolution and Adaptation*, 464.

considers that mutations occur chiefly under the stimulus of new conditions of nutrition. "These variations are the effect of past environment, . . . having remained latent until opportunity for their development occurs. Starvation causes reversions, but reversions can also be produced by unusually rich nutrition. New variations are developed most often, as far as environmental influences go, by rich soil and generally favorable conditions."* Crossing also tends to produce (or release) mutations. Further discussion of this subject may be postponed until the next chapter. The origin of variation is to be learned, if at all, through a study of the cell.

Given one-celled organisms, given also an environment partly constant, partly changing, and a sufficient time, and the evolution of the higher mammals is easily conceivable, on the mutation theory. On the whole, with many a back current, the movement of evolution has been upward. Generalized types have given place to those which are more specialized. Not only do we have special adaptations to special conditions, but there has been a gradual perfection of bodily structure, as well as intelligence, along a number of different lines. Thus the molluscs ended in the cephalopods, the reptiles in the saurians, and the mammals in man. Specialization, however, is usually carried too far and leads to extinction. With the restriction of natural selection to the function of weeding out the unfit, a good deal of the "blood" has been taken from our picture of the

* V. L. Kellogg, *Pop. Science Monthly,* LXIX, 363 (1906).

evolutionary process. Bitter struggle for existence, especially within the same species, is not a necessary factor.

Does the evolution of species lead us to assume an intelligent direction of the process? Not necessarily. The only external factor for which we have any evidence is the passive factor of environment. If there was any directing, it was with a very loose rein. Organisms, or at least mutating organisms, were apparently given the chance to see what they could make of themselves. Evolution seems to have been a kind of *laissez faire* on a grand scale.

The presence of organic and especially plant life during a long period has resulted in striking physical changes on this planet. Our present atmosphere is probably quite different in its proportions of oxygen and carbon dioxide, on account of the absorption of the former and discharge of the latter by all known organisms. The land surface is largely covered with green plants, whose leaves on the one hand prevent erosion, and whose roots on the other hand tend to break up physical masses and even molecules. Organisms have transferred and deposited vast amounts of inorganic material. Through their refuse and their own decomposition they have originated the long series of limestone rocks, the carbonaceous formations, the phosphate and nitrate beds, the corals and fossils, as well as the countless new acids and other compounds of organic chemistry. Great is the transforming power of organisms, even before the appearance of man.

CHAPTER VII

THE CELL

EVERY living being is made up of one or more cells, or organized masses of "protoplasm." These cells are microscopic in size, except in the case of some egg-cells, which grow to large proportions. The human ovum, a typical cell, is about 1/125 of an inch (2 mm.) in diameter. Although cells differ widely in structure and behavior, even to the extent of showing "individuality", all cells are of one general type, whether animal or vegetable, whether constituting the whole of a one-celled creature or making any one of the millions of specialized cells in the human body, whether body-cells, entering into the composition of some tissue, nerve, organ or fluid, or germ-cells from which complex organisms may in time develop.

The cell consists essentially of a cell-body and a nucleus. The material of the cell-body, known collectively as cytoplasm, contains most of the chemical elements included in protoplasm—carbon, oxygen, nitrogen, hydrogen and sulphur—which are present in elaborate and somewhat unstable compounds, showing wide variation.* The cell-body often contains smaller

* To illustrate, the following formulæ have been proposed for the albumins, some of the most characteristic of these compounds: egg-albumin, $C_{239}H_{386}N_{58}S_2O_{78}$; serum or blood albumin, $C_{450}H_{720}N_{116}S_6O_{140}$. Philip B. Hoyt, *Practical Physiolog. Chem.*, 1909, p. 62.

bodies, or plastids, apparently identical in substance, but capable in many cases of independent growth and division. These seem to be centers of chemical activity, especially in plants. Various lifeless bodies are also carried in suspension, such as food granules, sand, drops of oil or water, and waste. A great mass of reserve food is often accumulated, as in the yolk of the hen's egg. Portions of the cell-body deprived of a nucleus will, in many cases, survive for a time, moving about and rejecting waste, but they are incapable of either secretion, digestion or reproduction.

The nucleus is generally a distinct region of the cell, though in some cases the characteristic nuclear materials are scattered through the cell-body in the form of minute granules. The typical nucleus consists of a network made up of two constituents—linin, related chemically to the substances found in the cell-body, and a substance known as chromatin or nuclein—with a ground-substance or sap filling the interstices.

The chromatin, which appears to be the principal nuclear substance, with power to produce and determine the character of all the rest, is usually, during the resting stage of the cell, suspended as granules in the linin network. During the ripening of the cell it forms a number of masses called chromosomes.

"Nuclein", which reaches its greatest purity in chromosomes, has a very distinct chemical composition, rich in phosphorus and with practically no sulphur. During the resting stage the chromatin increases greatly in bulk, through the combination of nucleinic acid with albuminous matter. As the growth of cytoplasm is especially active during this stage, the nucleinic acid evidently plays a leading rôle in the metabolism of the cell. The nucleus is undoubtedly the center for constructive as the cytoplasm is the center for destructive metabolism. Not only is constructive metabolism impossible without a nucleus, but in some cases (for example, the growth of cell walls in plants) the nucleus moves to the point where growth is to be most active. The differentiation of the cell into nucleus and cytoplasm is evidently, as Wilson says, "the expression of a fundamental physiological division of labor in the cell."*

Another cell organ or cell region, the centrosome, has aroused a good deal of controversy. It has important functions in cell-division, and is found in the cytoplasm not far from the nucleus, into which it migrates during division. Like the plastids and chromosomes, the centrosomes appear to be capable of independent assimilation, growth and division. Boveri's theory that the centrosome was a permanent cell organ, the "dynamic center" of the cell, cannot be held in its original form. In many of the higher plants no centrosomes have been found, and in other cases they disappear at the close of cell-division, to be formed again later, perhaps at the same point. They are evidently more or less persistent centers of chemical activity. Centrosomes have been artificially developed in the cell by treatment with sea water or other solutions.

* E. B. Wilson, *The Cell*, 358.

The cell multiplies by division, and every cell is derived from some pre-existing cell. In normal division, by "mitosis," the centrosome divides and enters the region hitherto known as the nucleus. The chromatin decreases rapidly in bulk and increases in chemical strength (especially in the amount of phosphorus) and changes from a network into one or more threads. These in turn break up into the chromosomes. Each species has a definite and apparently arbitrary number of these, practically always even, ranging from two to one hundred and sixty-eight. They are remarkably persistent, both in number and substance. Each chromosome now splits lengthwise into exactly similar halves. The two groups of halves aggregate into new nuclei, and the entire cell divides into two new cells like unto the first. The essence of the process is the receiving by the daughter nuclei of exactly similar portions of chromatin. Artificial mitosis has been produced by chemical stimulation.

Passing to the germ-cells, we find that here division is associated with an exactly opposite process—conjugation. In some of the lowest forms ordinary mitosis may be sufficient for the perpetuation of the species, though even this is not certain. But in almost all cases, even among unicellular forms, "the series of cell divisions tends to run in cycles, in each of which the energy of division finally comes to an end and is only restored by an admixture of living matter derived from another cell."*

* *Id.*, 178.

We may quote a further summary from Prof. Wilson: "In the lowest forms, such as the unicellular algæ, the conjugating cells are, in a morphological sense, precisely equivalent, and conjugation takes place between corresponding elements, nucleus uniting with nucleus, cell-body with cell-body, and even, in some cases, plastid with plastid. . . . As we rise in the scale, the conjugating cells diverge more and more, until in the higher plants and animals they differ widely not only in form and size, but also in their internal structure, and to such an extent that they are no longer equivalent either morphologically or physiologically. Both in animals and in plants the paternal germ-cell loses most of its cytoplasm, the main bulk of which, and hence the main body of the embryo, is now supplied by the egg; and in the higher plants the egg alone supplies the plastids, which are thus supplied by the mother alone. On the other hand, the paternal germ-cell is the carrier of something which incites the egg to development, and thus constitutes the fertilizing element in the narrower sense. There is strong ground for the conclusion that in the animal spermatozoön this element is, if not an actual centrosome, a body or a substance directly derived from a centrosome of the parent body and contained in the middle piece. . . . Like mitosis, fertilization is perhaps at bottom a chemical process, the stimulus to development being given by a specific chemical substance carried in some cases by an individualized centrosome or one of its morphological products, in other cases by less definitely formed material. . . . Through the differentiation between the paternal and germ-cells in the higher forms indicated above, their original morphological equivalence is lost and only the nuclei remain of exactly the same value. This is shown by their history in fertilization, each giving rise to the same number of chromosomes exactly similar in form, size, and staining-reactions, equally distributed by cleavage to the daughter-cells, and probably to all the cells of the body. We thus find the essential fact of fertilization and sexual reproduction to be a union of equivalent nuclei, and to this all other processes are tributary."*

The ripening of the germ-cells preparatory to conjugation is of great interest. In both the maternal and the paternal cells the number of chromosomes is reduced to one-half the typical number, as a preparation for their future union, in order to hold the number constant. In the case of the paternal cell, this reduction is effected by two divisions, through which the nuclear material is distributed among four spermatozoa, only one of which is to take part in fertilization. Each has one-half the typical number of chromosomes. In the egg-cell there is a parallel process by which three of the four cells are discarded, though persisting for a time as "polar bodies." In many cases, with both maternal and paternal cells, the masses of chromatin show a cleavage into four, in preparation for the two maturation divisions of the cell. The first cleavage is lengthwise, as in the usual mitosis. Some students of the

* *Id.*, 229.

subject—for example, Weismann—have claimed that the second cleavage is crosswise, and so preserves (in the egg-cell or successful spermatozoön) or rejects (in the polar bodies) any particular region of the chromatin-thread. On this Weismann's theory of heredity was largely based. To a certain extent the facts bear out this theory, but there is not as yet evidence for the universality either of tetrad formation or of this transverse cleavage.

Experiments by Delage show that fertilization may take place between a spermatozoön and a fragment of an ovum which contains a nucleus. Loeb has demonstrated the converse, that a sperm-nucleus may be dispensed with, by inducing artificial parthenogenesis through chemical treatment. In other words, both the paternal and the maternal germ-cells of early forms are completely equipped for reproducing the organism. In natural parthenogenesis, which alternates with sexual fertilization in many early forms, the germ-cell ripens, in the same individual, in one of two ways. Either one polar body is formed and discarded without reduction of the chromosomes, or a second polar body is formed, accompanied by reduction, and, remaining in the egg, plays the part of a sperm-nucleus.

The typical cell has the power of producing, by division, other cells like itself.* On the other hand, the fertilized egg (however fertilization may have taken place) by an exactly similar process of division gives

* Nerve-cells have probably lost the power of division, and connective tissue-cells, gland-cells and muscle-cells divide only under special conditions.

rise to cells showing progressive differentiation, and the division of labor necessary to the organism. This distinction between body- and germ-cells is itself a division of labor. In some of the colony-cells of the protozoa two kinds of cells are already found—a few large germ-cells, and a large number of smaller cells, used for metabolism and locomotion, which are comparatively short-lived. Weismann has emphasized the continuity of the germ-plasm, and the general truth of his position is fairly well established. The cells which are from the first differentiated as germ-cells (or, which remain unspecialized) continue to produce other germ-cells of the same sort until fertilization occurs. They then give rise to body-cells, but there is no known way by which the body-cells in their turn can affect the germ-cells. There seems to be no machinery through which characters acquired by the organism can be transmitted, unless in a general way through good or bad nutrition. But this apparent negative may be due to our imperfect knowledge of the subject.

We as yet know little of the mechanism of inheritance, in spite of the many theories on the subject. In the early cleavages of the fertilized egg, the size and position of each cell is directly related to the part of the body to which it gives rise. In fact, the egg itself in many cases shows indications of future lines of cleavage. Cleavages continue to follow one another with great rapidity until the plant or animal approaches its hereditary limit of growth.

In some animals, as high in the scale as the amphioxus, the protoplasm of the egg seems for several divisions to be "toti-potent"—able by rearrangement to produce a relatively complete organism from any one of the dividing cells. Thus, if one of the first two cells of the amphioxus is isolated, it will give rise to a regular amphioxus of reduced size. In experiments on frogs in the two-celled stage it was found that one of the cells will give rise to a half-embryo, if left in its normal position. If inverted, it will give rise either to a half-embryo or to a whole dwarf. Almost all simple animal organisms have this power, as seen not only in regeneration of lost parts but in frequent reproduction by budding. Many of the higher plants retain the power of total regeneration, but in animals it is soon lost. This, in turn, might be due to the gradual differentiation of the cell-nuclei—that is, to a distribution of the various modifications present in the chromatin of the fertilized egg (Weismann's determinants, Driesch's ferments). But such a view is still hypothetical, or worse.

There has been much study and much controversy over the question of biological units. Are there units intervening between molecules and cells? We cannot give such a character to the chromosomes, for these appear to fuse during the resting stage. Nor are we justified in treating the chromatin granules as persistent individuals. In unicellular organisms with a distributed nucleus these granules seem to persist, and divide to form new granules. But in higher forms, although division may take place, the granules fuse and their number is not constant. In the cytoplasm, distinct granules are often present, but there is no evidence that they are individual units. The persistence and division of plastids and centrosomes is suggestive but no more. If smaller biological units exist, they must be below the limit of microscopic vision. Many facts —for example, Mendel's law—point *toward* such a theory, which would clear up the biological field as electrons have cleared up the physical, but it has as yet no solid basis in fact. Weismann's elaborate theory of units has its basis chiefly in imagination.

In the case of unicellular organisms, and also of the germ-cells, at least in certain stages, the cell is an independent living being, carrying on the several co-operative activities which are necessary to life. All cells have a certain amount of independence, more or less according to their place and function in the body. But the trend of biological opinion is against treating the organism as a colony or republic of co-operating units, and toward the view "that life can only be properly regarded as a property of the cell-system as a whole."* Even the independent functions of the different cells —metabolism, regeneration, etc.—are definitely correlated with the organization and condition of the body. Apart from the whole a cell soon dies, unless, in some cases, grafted on another whole, or, in other cases, becoming itself a new organism. This question will be discussed more fully in Chapter IX.

* Wilson, p. 29.

A subject of great interest and importance, as yet little studied, is the mechanism by which the different cells are connected with each other and so coördinated to form a complete organism. Protoplasmic bridges are known to connect the cells of nearly all plant and many animal tissues. It has been shown that the membrane-forming power of certain plant-cells, when deprived of a nucleus, is due to connection by protoplasmic strands with a nucleated fragment. There is some evidence that cell-bridges may be formed and re-formed with great freedom.

Cells when studied in section under the microscope are necessarily solid. The living cell is partially liquid. It is not only surrounded but permeated by water (protoplasm contains about eighty per cent) and the jelly of the cytoplasm liquifies at death. The reactions of physiological chemistry may be said to be reactions in solution. Such complicated changes and exchanges could not take place in any other state.

The molecules held in solution and taking part in these reactions are classified as either colloids or crystalloids. Colloids may be defined as non-conducting, asymmetrical, jelly-like molecules, of great molecular weight, which diffuse with extreme slowness if at all. They constitute the principal and distinctive material of protoplasm. The important thing to remember about colloids is their great bulk. They are very unstable, constantly passing into new combinations. They do not leave the cell, or their department of the cell, unless broken up into smaller molecules.

Crystalloids, on the other hand,* are small symmetrical molecules which diffuse rapidly in solution, even through a colloidal membrane. Diffusion through a membrane of some sort is known as *osmosis.* The solutions on either side of the semi-permeable wall seek to reach an equilibrium. The rate of diffusion and the "osmotic pressure" vary, in a rough proportion, directly with the number of molecules (concentration of the solution) and their velocity (temperature) and inversely with their size. In general, it is the crystalloid molecules present in the fluid surrounding the cell which take part in osmosis, through the cell wall or boundary. They then diffuse through the cytoplasm and nucleus, and act upon or combine with the colloids. Water diffuses rapidly in the same way in and out of the cell, according to the pressure. The same result may be reached by filtration through minute tubes, as in the capillaries of the blood vessels. The energy transformations involved in all these processes (considered by themselves, without reference to what initiates or controls the transformation) are as purely physical as if we were dealing with solutions of mineral salts.†

These statements may be illustrated by a brief outline of the process of metabolism, through which the cell is able to continue its life. Taking first the case of plants, we find that the necessary carbon is obtained

* The two classes undoubtedly shade into each other. See Zsigmondy, *Colloids and the Ultramicroscope,* trans. by J. Alexander, New York, 1909.

† For a discussion of the energetics of solution, see the volume edited by Leonard Hill, *Recent Advances in Physiology and Bio-Chemistry,* London, 1905, Chap. II *et passim.*

from the air, where small quantities are present in combination with oxygen in the form of carbonic acid gas (CO_2). The carbon is extracted by means of the chlorophyll grains or bands found in the plant cell or in the outer cells of the leaves. Practically all active plant organisms are provided with chlorophyll, unless depending on food previously stored, or, in the case of parasites, on material gathered by other organisms. These chlorophyll bodies (among the plastids to which we have already referred in our description of the cytoplasm) develop only in the presence of light, and only when iron is present in the cell. Their peculiar chemical properties appear to reside in the green pigment. Under the action of sunlight, particularly the red and yellow rays, chlorophyll is able to break up the molecule of carbon dioxide, retaining the carbon and giving off free oxygen. A small amount of carbon dioxide is also absorbed by the roots and carried to the chlorophyll bodies.

The other chemical elements necessary for the growth of the plant are absorbed in the form of water, either as aqueous solutions or as solids. In one-celled and aquatic plants the absorption takes place at the surface of the cell; in the higher land-plants through the root-hairs attached to the roots. These root-hairs contain acids which aid in the solution of certain solids.

The carbon absorbed by the chlorophyll bodies is combined with oxygen and hydrogen to form the colloid known as starch, which has the proportions C_6H_{10}

O_5, the molecule, however, being compound and extremely bulky. A combination of this type is generally known as a carbohydrate. Certain ferments produced by the protoplasm break up the starch molecules and change them into one of the simpler sugars with the formula $C_6H_{12}O_6$. These molecules in turn are transformed into proteids, the principal factor in protoplasm, by the addition of nitrogen and sulphur, aided by the presence of minute quantities of potassium, magnesium and probably iron. For the nucleo-proteids phosphorus is necessary. Fats are also present in the cell, derived from starch and containing the same elements, but in very different proportions; the process of formation is still a matter of debate. Various ferments may assist in the elaboration of these different elements. Carbohydrate molecules may be held in reserve as such, or used in the formation of fibres, gums, etc. The plant seed is especially rich in reserve material; even before germination this reserve is being slowly drawn on to continue the activities of the cell.

In the higher plants the ascending sap consists of water holding in solution the minerals derived from the soil and certain sugars drawn from the reserve material in the cells. On reaching the leaves, carbon is added in the form of starch or one of its derivatives and the elaborated sap diffuses from cell to cell throughout the organism, apparently through the cell walls. Out of the materials thus derived each cell forms the necessary proteids, carbohydrates and fats. Surplus water is exhaled from the leaves, and this evaporation, rendering the substance of the outer cells less fluid, causes fluid to diffuse to them from the neighboring cells. This process of osmosis, continuing from cell to cell as far as the roots of the plant, represents the upward movement of the sap. The higher temperature of the leaves assists the process, chiefly by increasing the evaporation. The sap rises with considerable force. The upward movement takes place chiefly during the first warm months and in the daytime. Besides water-vapor, much oxygen is given out from the leaves, and small quantities of some other gases. But most of the material received is assimilated, and plant metabolism is thus essentially constructive.

Animal metabolism is both constructive and destructive. As chlorophyll or an equivalent pigment is not found in any animal organisms (except some of the flagellata), they are dependent for their supply of carbon on that gathered by plants and already elaborated into carbohydrates, proteids and fats. For purposes of digestion it is necessary for the animal to break up these different food elements. This is accomplished by means of ferments, chiefly enzymes, which will be discussed in the next chapter.

A one-celled organism, such as the amœba, captures and then engulfs its food. Fat, starch and other material that cannot be utilized is ejected without change. Proteids are acted on by a digestive fluid resembling pepsin. The materials thus obtained are used for the growth of the cell and the repair of any of the protoplasm used up in its movements or other life processes.

The chief source of energy is the carbon, which is oxidized—that is, combined with oxygen—and given off by the cell in the form of carbon dioxide.

The general process is the same in the higher animals, with their marvellous specialization of organs and cells. The molecules of food elements and mineral salts taken into the body are broken up in their passage by the aid of secretions furnished by various organs, glands and cells. The simpler molecules thus formed and held in solution are absorbed by the blood, through the walls of the alimentary canal. The blood conveys these molecules, together with the oxygen molecules supplied it by the lungs, to each cell in the body. (Water and salts are also furnished.) The behavior of the cell then resembles that of the amœba. The cell-substance is repaired through the oxidation of the carbon, and the resulting carbon dioxide is carried back by the blood to the lungs, or to the pores, and exhaled. Similarly, other waste, chiefly water and nitrogen, is returned by the blood and lymph to the kidneys or the alimentary canal, whence it may be carried out of the body with the food material not absorbed by the system.

One of the latest students of the subject states that "a cell cannot control the diffusion of substances into itself, nor can it choose from its surroundings any one substance and leave another. Even at the expense of its life, a cell is bound to absorb from its surroundings any substance which may be present; and this absorption depends entirely upon certain chemical and physical factors."* The protoplasm of the different cells, however, acts differently upon the substance absorbed, so that each cell normally receives the quantity and proportion of the various food elements necessary for its functions. The calcium and other elements present in the bony skeleton are deposited in a similar way through adjoining cells serving this special purpose. In the absence of food, the cells are able for a certain period to draw on their reserve material or that of cells especially rich in carbon. Very little oxygen is held in reserve.

When life ceases in the organism, whether plant or animal, the molecules, if not at once used by other animals for food, tend to be broken up into simpler forms. The process is assisted by various micro-organisms. Some of these are present in different organs of the body; they are held in check by the cells or secretions of the living organism, but develop unchecked when life ceases. Of the resulting elements, the oxygen and hydrogen tend to escape in the form of gas, often in combination with carbon. Water is also formed, and some carbohydrates are found in the form of fluids. Most of the carbon, however, as well as the nitrogen, sulphur, phosphorus and mineral salts, return to the soil in a more or less impure state. There, with the exception of carbon, they are again available for plant food, as is the case with animal waste.

Some reference should be made to the subject of organic heat, as it has important bearings on the rela-

* H. C. Ross, *Induced Cell-Reproduction and Cancer*, 1911, p. 65.

tion between biology and physics. No organisms are active except within a certain specific range of temperature. This simply means that heat is necessary for the chemical changes on which life depends. Heat is ultimately derived from the sun. It may come to the organism directly, less directly through surrounding objects or the atmosphere, or through chemical changes in other organic matter. A certain amount of solar heat, as well as light, is necessary for the decomposition of carbon dioxide and the formation of new carbon compounds. This heat energy, derived from the radiant energy of the sun's rays, has been transformed into chemical (electrical) energy, or is represented by heat energy in another form, the increased kinetic energy of the atoms making up the new molecule. When these carbon compounds are broken up and the carbon is again combined with oxygen, processes for which additional heat is necessary, the total increase of energy is given off. It may be given off as heat, partly radiated, partly used for new chemical processes. It may be converted into molar motion—of the cell, of some of its parts, or of the organism—thus supplying the energy necessary for the cell's life-functions or for its work. The process is somewhat similar to the oxidation of carbon in the fire-pot of an engine. In muscular work, about one-fifth of the heat generated is available for mechanical work, the other four-fifths being required to start the necessary chemical changes in the cells.

A man of average weight, doing a moderate amount of light muscular work, requires about one hundred grams of proteids, one hundred grams of fats, and two hundred and forty grams of carbohydrates, or a total of two hundred and thirty-five grams of carbon per day, with a fuel value in metabolism of 2324 kilogram calories. The fuel value is measured in a calorimeter, and is the amount of heat which would be radiated on the complete oxidation of the carbon available in the food elements given. Approximately the same results have been obtained by measuring the radiation from the body during twenty-four hours. Hard muscular work must be compensated by additional carbon.

Organic chemistry, from this point of view, is a study of carbon compounds. Carbon is the medium for heat exchanges, not because of the ease with which it is obtained—it must be separated by chlorophyll from the .03 per cent of CO_2 in the atmosphere—but because of the readiness with which it combines with and separates from oxygen, a principal constituent of both atmosphere and hydrosphere. All the carbon compounds used by us as fuel have been derived ultimately from carbon dioxide, and the energy stored in them has come from the sun's rays. The quantity of heat given off when wood is burned is supposed to be the equivalent of the heat required for its formation. Plants and animals, through their elaboration of reserve carbon material, are "storehouses of energy". For the decomposition of the dead organism a certain amount of heat is required. A very much larger amount is given off, for the most part in the form of radiation, as the various compound molecules are broken up.

From another viewpoint, biological chemistry is the study of nitrogen compounds. Nitrogen forms the basis of the elaborate albumin molecules characteristic of all cells, and hence necessary for cell food in the form of proteids. Though a common element, making seventy-seven per cent of the atmosphere, nitrogen is very inert and combines only with great difficulty. Just why it should be fundamental in protoplasm we do not know. One way in which the nitrogen in the air is rendered available for organic life is through electric discharges in moist air, forming ammonium nitrite, which is carried by rains into the soil. Nitrogen is also secured directly from the atmosphere by certain nitrogen-gathering bacteria, which are parasitic to leguminous plants.

Other bacteria, not parasitic, have been discovered in the soil, which in one case oxidize ammonia and in the other oxidize nitrites. These two classes of bacteria are of special interest from the fact that they are the only organisms thus far known which are able to utilize carbon dioxide directly, without the aid of chlorophyll. They build proteid molecules simply from inorganic salts. The energy necessary for this process appears to be supplied by the oxidation of the nitrogen. Sulphur is also oxidized by some bacteria. A certain amount of plant energy is derived from the ultra-red rays of the spectrum.

The albumins are so complex, and in many cases so fleeting, that analysis has been difficult. Considerable progress, however, has been made along this line, chiefly through the brilliant work of Emil Fischer of Berlin. Various albuminous substances have been broken up into derivatives of ammonia, known as amino-acids, and into other nitrogen compounds. After the composition of these derivatives had been thoroughly studied, the attempt was made to put them together again. Fischer has succeeded in preparing an artificial peptide with a molecular weight of 1213; natural peptides weigh between 2,000 and 3,000. Probably in time we shall be able to build peptides into the more complex peptones, and these in turn into albumins proper. The latter are considered by some authorities to have a molecular weight as high as 15,000.

CHAPTER VIII

HOW FAR DOES CHEMISTRY CARRY US?

THE preceding story could not have been told without frequent reference to the chemistry of the cell. More and more chemistry is likely to prove the pass-key to biological problems. In the present chapter I propose to carry this subject further, taking up a series of recent experiments, from widely different fields, bearing on the way in which chemical changes in the surrounding fluid affect the behavior of the cell.

Mention has already been made of artificial mitosis, fertilization and the development of centrosomes. The leader in such work has been Professor Jacques Loeb of the University of California. To refer to some of his later work, in 1903 he succeeded in fertilizing the egg of a sea urchin with the sperm of a starfish. It could not be done in normal sea water, but was possible in a number of solutions. These solutions prevented or made difficult the fertilization of the sea urchin by the sperm of its own species. In 1905 parthenogenesis was induced in the sea-urchin's egg by increasing the osmotic pressure of the surrounding medium. This caused the loss of water by the egg and the formation of a membrane, as in fertilization. In 1906 he proved that segmentation and development require the presence of free oxygen and are primarily oxidative processes.*

Loeb has also done distinguished service in the investigation of the various tropisms, or "turnings," which are the basis of many of the commoner instincts. They might be enumerated as follows: thermotropism, or response to a change of temperature, considered as a stimulus; thigmotropism, or response to mechanical stimulation; chemicotropism, or response to chemical stimulation; geotropism, or response to the force of gravity; and heliotropism, positive and negative, the tendency of an organism to turn toward or away from light. These tropisms have been proved to be identical for plants and animals. They are undoubtedly physico-chemical phenomena. Their exact nature is in most cases unknown, but the tropic tendencies of the organism may be modified by changes in the medium. For example, heliotropic reactions in fresh-water crustaceans have been modified by various chemicals, especially CO_2.† Tropisms depend, first, "upon the specific irritability of certain elements of the body-surface, and, second, upon the relations of symmetry of the body. Symmetrical elements at the surface of the body have the same irritability; unsymmetrical elements have a different irritability. Those nearer the oral pole [toward the mouth] possess an irritability greater than that of those near the aboral pole. These circumstances force an animal to orient itself toward a

* *Univ. of Cal. Pub's in Physiology,* vols. I-III.
† *Op. cit.* II, 1 *ff* (1904).

source of stimulation in such a way that symmetrical points on the surface of the body are stimulated equally. In this way the animals are led without will of their own either toward the source of the stimulus or away from it."*

A fairly strong case has been made out for the chemical explanation of rhythmical movements. Loeb considers these to be due to the exchange of sodium or potassium atoms for those of calcium or magnesium, or *vice versa.* The former increase the rate of contraction in a muscle cell; the latter diminish it. The center of one of the medusæ, when isolated, was able to beat rhythmically in a pure solution of sodium chloride. The greater the concentration of the solution, the more rapid the movements, within certain limits. Movements, however, were slowed down or inhibited or magnesium chloride. Again, if too many sodium ions enter the tissues of the center, it will lose its irritability; this may be restored by adding a trace of calcium chloride to the solution.† "The peculiar qualities of each tissue are partly due to the fact that it contains ions (sodium, potassium, calcium and others) in definite proportions. By changing these proportions, we can import to a tissue properties which it does not ordinarily possess. If in the muscles of the skeleton the sodium ions be increased and the calcium ions be reduced, the muscles are able to contract rhythmically, like the heart. It is only the presence of calcium ions

* Loeb, *Comparative Physiology,* 1902, p. 7.
† *Id., Dynamics of Living Matter,* 1906, p. 78 *ff.*

in the blood which prevents the muscles of our skeletons from beating rhythmically in our body."* The part of an organ which contracts with the greatest frequency forces the other parts to contract in the same rhythm.

We may put beside this group of experiments the work done recently by Carrel and Burrows at the Rockefeller Institute, New York, in the cultivation of adult tissues and organs outside of the body. Fragments of animal tissues were placed in a plasmatic medium taken from the same animal and kept at normal temperature. Many of the specimens grew normally. Glands were cultivated in the same way, and also kidneys, proving that adult tissues may be grown outside of the body as easily as many microbes. The following summary may be given of some of their later work: "It is concluded by Carrel and Burrows that the degree of dilution of the culture medium has a marked influence on the rate of growth of splenic tissue. The maximum acceleration was obtained in a medium composed of three volumes of normal plasma and two volumes of distilled water. The growth in this hypotonic plasma was very much larger than in normal plasma. On the contrary, the growth of the spleen in hypertonic plasma was always less than in normal plasma. In other experiments, they found that in diluted plasma there was also an acceleration of the growth of the skin, the heart, and the liver of chickens. The skin of adult frogs also grew more actively in

* *Physiology*, p. 9.

this plasma. The optimum degree of dilution varied according to the nature of the tissues and to the species of the animals. While the plasma containing two-fifths distilled water produced the largest growth of splenic tissue, a slightly less diluted medium was more favorable for the liver and the heart, and generally for the skin also."*

The third series of discoveries to which I refer are the microscopic studies of the living cell by Dr. Hugh Campbell Ross of the Royal Southern Hospital, Liverpool. Heretofore only sections of dead cells could be stained to bring out their various parts under the microscope. It is by such means that material has been gathered for the general theory of the cell given in Chapter VII. Dr. Ross has discovered a method of staining living cells and keeping them alive for a few hours, so that they can be examined and photographed while being subjected to any conditions desired. This *in vitro* method seems likely to modify many of our views as to cell-structure, and revolutionize our views as to cell-behavior.

Among the facts already proved by Dr. Ross is the chemical basis for ordinary mitosis. The division of the cell is not due to an inward propensity, but to the presence in the surrounding medium of some one of a group of substances, among which kreatin, xanthin and globin have been identified.† These chemical

* *Journal of the Am. Med. Assoc.*, LVI, 1513 (1911); see previous articles by the doctors themselves in the same journal.

† The first two are amino-acids, their formlæ being, respectively, $C_4H_9N_3O_2$ and $C_5H_4N_4O_2$.

agents, to which Ross has given the name "auxetics," "are contained in the remains of dead tissues. When a tissue is damaged anywhere, cell-death is occasioned, and the dead cells liquify. The products of this death have as constituents the extractives kreatin and xanthin, and we know that the neighboring living cells must absorb the liquified remains of their dead neighbors, for it has been shown that the diffusion of substances into living cells is a physical process over which the cells themselves can exercise no control. When a tissue is damaged, therefore, the direct result of that damage will be to make the neighboring living cells reproduce themselves in response to kreatin and xanthin and bring about the cell-proliferation of healing."* Cancer is shown to be an exuberant growth caused by the action of "a normal auxetic plus an alkeloid of putrefaction and decomposition." The lack of mitosis in the colorless cells of the blood and lymph is undoubtedly due to a power which the blood possesses of restraining the action of globin and other auxetics contained in it.

Reference should also be made to the series of discoveries which form the basis for the modern science of therapeutics, as distinguished from the empirical use of drugs. We have learned that when certain substances known as antigens—present in bacteria or other cells, or in fluids—enter the general circulation of an animal organism, they lead to the production of specific "antibodies" corresponding. That is, the particular antibody, if present in some group of cells, is called out in

* H. C. Ross, *Induced Cell-Reproduction and Cancer*, 1911, p. 320.

increased quantity by this new need. (The reaction of the organism takes this form, the production of the anti-body or of anti-body-forming cells often disturbing the other processes of metabolism.) The anti-body, whether remaining in the cell which produced it or passing out into the plasma, acts as a receptor for the antigen. It either combines with it, thus neutralizing its action, or combines with a third substance present in normal plasma to cause the dissolution of the antigen molecules, or the death of the bacteria carrying them. After developing such an anti-body, the animal is likely to be immune. Immunity may also be secured either by inoculating with a toxin whose virulence has been diminished, the organism developing the necessary anti-body gradually and safely, or by borrowing the antitoxin developed by another organism. The pioneer in this field, Ehrlich of Frankfort, after long experimentation, has now succeeded in manufacturing a drug, salvarsan, which acts as an anti-body to the syphilis bacillus, combining with and destroying it, while leaving the other tissues of the animal unaffected.

The discovery was recently made that many, perhaps all, secreting tissues and organs, in addition to the secretions which take part in digestion, discharge into the blood other secretions known as "hormones." These reach and affect all parts of the body, causing other glands to secrete, and thus bringing about the correlation of organic processes. I understand that if some of the blood from the after-birth of a rabbit is injected into a virgin doe it will cause the secretion of milk. The normal secretion of the pancreas is stimulated chiefly by a secretion from the duodenum, which is absorbed by the blood and carried around to the pancreas through the general circulation.

The velocity of reactions in organic chemistry is affected in a remarkable way by the presence of enzymes, or unorganized ferments. Recent study has shown that there are no organized ferments. The yeast cell, for example, is not itself a ferment, but elaborates zymase as its principal enzyme. Enzymes of some sort or several sorts appear to be elaborated by all animal and many plant cells. They are "catalysts"—that is, they are capable of starting or accelerating certain chemical reactions without being themselves altered or becoming part of the resulting product. In other words, they form unstable intermediary compounds. Two substances capable of combination may remain side by side in solution without combining, until an enzyme is added which brings about a new equilibrium in the solution.

The action of each enzyme is specific. It affects in a definite way a substance or group of substances and (in most cases) no others. The action is usually destructive. Some instances of "reverse" action are known, however. Thus maltase changes maltose into the simpler molecule, glucose. When applied to a very concentrated solution of glucose it causes the formation of a substance similar to maltose. The concentration of the solution has increased the molecular energy, represented by cohesion, surface tension, molecular velocity, or whatever force hinders chemical reaction. This increased molecular energy is capable of transformation into chemical energy on the addition of the proper transformer.*

Thus far it has proved impossible to isolate enzymes, so that little is known of their chemical composition. They are colloids, and somewhat resemble the proteins, with which they are closely associated. They are elaborated only by living cells, but, once formed, are largely independent of life. The cell first produces a mother-ferment, which becomes active through contact with certain specific excitors. Up to a certain maximum, the activity of an enzyme is, in general, proportional to its concentration. Action is inhibited by lowering the temperature, and the activity of the enzyme, when in solution, is destroyed by 100° C or less; also by certain poisons. In this it resembles the living cell. Enzymes in a dried condition, like dried bacteria, can be heated considerably above the boiling point. Some enzymes are destroyed by sunlight, like bacteria. Chlorophyll and other plant plastids are not enzymes, though they serve much the same purpose. The various inorganic catalysts, such as acids, alkalies and mineral salts, are crystalloids. They are more

* "A catalyst or enzyme which at one set of concentrations increases the velocity of a reaction in one direction must equally hasten it at another set of concentrations in the opposite direction. In other words, all catalytic action must be reversible, although in most instances the equilibrium point lies so near one end that the action of the enzyme on the velocity of reaction in one of the directions cannot be demonstrated experimentally." Benjamin Moore, *Recent Advances in Physiology and Bio-Chemistry,* 1905, p. 55.

active in some ways, because of the smaller molecule, and less easily destroyed.

The cell itself, while using various catalysts, is itself an energy-transformer with greatly enlarged powers. To quote from Professor Moore: "1. The action of the soluble or unorganized catalyst or enzyme may consist (a) in commencing a reaction which does not proceed at all in its absence; (b) in altering the velocity of a reaction which does proceed in its absence, and such action may be positive, increasing the speed of the reaction, or negative, diminishing the speed of the reaction; but (c) the direction of reaction must always be toward the point of equilibrium, because the enzyme does not yield energy itself, and is unable to act as a transformer to external energy, or to link two chemical reactions so as to obtain energy from one for the performance of the other.

"2. The living cell as an energy-transformer, in addition to the actions (a) and (b) of the enzyme, can store up chemical energy, either by using energy in other forms and converting it into chemical energy, or by linking several reactions together and transforming the chemical energy obtained from some back to chemical energy which is stored up in others. Finally, the cell can modify its activities, and alter in its action as a transformer, changing entirely the course of the reactions it induces and the products obtained, while the type of action of the enzyme is simple, selective, and entirely fixed. There is no doubt whatever that the cell makes use of the action of many intracellular enzymes for the chemical transformations it induces, but in all cases the action of such enzymes is adapted, controlled, and coördinated by the cell." *

What is life? What is this something which compels us to add to the merely physical sciences the science of biology? Our answer must be inductive, and the question should first be put in the simpler, more concrete form: "What is organism?" Life on this planet, as we know it and are able to study it, is always organized; it has a definite physical basis. What then distinguishes a living organism, plant or animal, lower or higher, from the same aggregation of atoms before life is present, or after life has ceased? We find, in every case, three and probably four principal characteristics, which we might term the categories of biology.

First, *movement*. In physical masses there is a passive, mechanical response to external stimuli. Certain chemical substances will affect the atoms of a body; a rise of temperature will increase the velocity of its molecules. Decrease of pressure in the medium will cause the body to rise. A piece of iron, floating on a cork, will move toward a magnet. There is no reason to suppose that a dead organism would show energy-phenomena of a higher order. The death-test of cells under a microscope is the lack of "amœba-like" movements, when stimulated by an alkali.

The response of the living organism to the same stimuli is of an entirely different character. The cell, as we have noted, acts as an energy-transformer. Take

* *Recent Advances in Physiology,* p. 50.

the "irritability" of the simplest organism, as shown by its various tropisms. The cell is stimulated by some chemical substance or by light. Not only is there a chemical or molecular response, as in the case of the physical mass, but the stimulus when received is transmitted through the organism (conductivity), some of the carbon of the cell is oxidized to convert heat energy into molar motion—of the cilia or other parts—and the cell moves in a direction determined by the character of the stimulus and the chemical and physical symmetry of the organism. Each unicellar shows most of the tropisms which I have before enumerated. The resulting movements may not be of any special advantage,* but they constitute a response to the environment. How far the movements of higher organisms are to be considered tropisms we need not discuss at this point. The adjustment to environment becomes very complex. The animal moves freely: in search of food, to escape enemies, to meet its mate, to lay its eggs, to secure a more favorable habitat. Even in plants which have lost the power of free movement, the leaves and flowers are more or less heliotropic and the root-hairs are constantly seeking out new sources of moisture. The development of each cell and of each organism shows a constant and active adjustment between internal and external relations. Countless examples of the same power could be given from the survival of mutations and the evolution of species and organs.

The striking thing about the various movements of

* See description of the paramecium on p. 157.

this organic adjustment is that they represent the initiation of molar energy on the part of the living creature. The organism and its parts follow the familiar laws governing kinetic energy. To this extent the organism is like any other physical machine. But the living machine has, to a large extent, the power of starting and stopping its own machinery—that is, of changing molecular into molar energy. It is an active (though not necessarily "conscious" or "voluntary") energy-transformer.

In the process of metabolism, the movement of fluids within the organism, though largely mechanical, is also subject to vital control. One of the best examples is the diffusion through organic membranes, such as the air-cells of the lungs and the cellular walls of blood and lymph vessels. Instead of following the ordinary physical law of osmosis, where the diffusion is from the region of greater to the region of less pressure, the cells cause carbon dioxide and other fluids to pass in a reverse direction and increase the molecular pressure of the fluid. This is brought about through a transformation of some of the energy of the cell itself. In the kidneys, the concentration of the urea solution is increased from less than four-hundredths per cent in the blood to two per cent in the urine. The action of the cell in these cases is selective and varies according to the nature and concentration of the solution.* The distribution of blood and the rate of secretion of various fluids are regulated by the organism as a whole or

* *Recent Advances in Physiology,* 12 *ff.*

by certain groups of its cells. By nervous inhibitions the creature is able, to a limited extent, to control its own pumps and valves. The adjustment of organisms to environment is physics and something more.

Second, *metabolism,* the control of the chemical changes necessary for life. Every cell is a minute chemical laboratory, breaking up bulky food molecules into simpler forms. Various enzymes and other catalysts are necessary for destructive metabolism. By the use of these catalysts, at the proper temperature, some of the digestive processes of the cell may be duplicated by us in the laboratory. But the cell not only manages these chemical reactions, automatically selecting the proper material; it also supplies the enzymes for the purpose, which are found nowhere else, sometimes elaborating one enzyme rather than another, according to its needs.

The living cell, as we have seen, also uses heat energy derived from some of its material, chiefly carbon, to build up compound molecules of a size and complexity unknown to inorganic chemistry. To a very limited extent enzymes are able to build up more complex molecules, but only when the solution acted on is below the normal equilibrium. But a cell, to select one of the simplest instances, is able to absorb a soluble carbohydrate, oxidize part of the substance to yield energy, and use this energy to build up the remainder into molecules of fat, the new molecules being of very much greater bulk and possessing vastly greater chemical and atomic energy than the molecules of the carbohydrate.* Substantially this process is going on in every active cell of every organism in the world of biology. Metabolism appears to represent the initiation of chemical changes. Physical and chemical laws go on unaltered. The conservation of energy is not affected. But organisms have the power to transform heat energy into chemical energy, or *vice versa*, and so perpetuate their life.

Third, *regeneration*. We have seen that all plants, the lower animals and even the germs of higher animals in the first cleavages of development, are totipotent—that is, they are able to restore a complete individual like the parent. In many of these lower forms, as in all higher animal forms, the power of generating a new organism like the parent also resides in the germ-cells. This is simply a division of function; fundamentally the process is the same in both cases. We no more understand how the larva of a salamander, after the lens of the eye has been removed, can restore a perfect lens from the posterior layer of the iris,† than we understand why the organism developed from a fertilized mammalian ovum will turn into an almost exact reproduction of one or both parents. The mechanism of the process is entirely beyond our present knowledge. But all normal organisms have this power of regeneration, to which the physical world offers no analogy.

The two facts to be noted are: First, the fact of regeneration—the fact that all life comes from some

* *Id.*, 17.

† Wilson, *The Cell*, 433.

previous life and seems destined to the production of new life in its turn. Every cell comes from the division of some pre-existing cell. Second, the new life shows "heredity," or what Wilson aptly calls "biological memory." That is, in its growth into a complete organism it repeats the developmental process of its parents, and to some extent of the species and of the living race. Past experiences are in some way impressed upon the "germ-plasm", the continuous cell-substance. One of the most interesting examples of this is the preparation of both maternal and paternal germ-cells for conjugation. Normally the number of chromosomes is reduced one-half, in order that, when union of the cells takes place, there may be the typical number of chromosomes in the united cell. Conjugation may not take place, but the germ cells have "remembered" their proper function.

Fourth, *variation,* a factor as yet little understood. It may be merely a failure of the organism completely to reproduce its ancestral life, and this failure may be due to the action of physical or chemical causes during the process of development. In that case variation would not strictly be a category of biology. On the other hand, it may be a power inherent in organism itself, as the recent study of discontinuous variation by de Vries and others appears to indicate. This power, however, is shown only by a certain proportion of the organisms in a group, the others breeding true. Are we to suppose that many organisms lack this power altogether, or that it is in some way latent in all?

Philosophy can ask a great many questions that biology is still unable to answer.

We may now define life provisionally as that which, added to the elements known collectively as protoplasm and having purely physical attributes, organizes those elements into a machine which has the power of movement, metabolism, regeneration, and probably variation. I mean this to be merely an empirical definition, which will not commit us to either mechanism or vitalism.

CHAPTER IX

THE ORIGIN OF LIFE

LEAVING for the present the further study of life itself, we may turn to the question of its source. Most writers on this subject have ignored the extreme complexity of even the simplest forms of life found on this planet. To live, in any real sense, an organism requires the assembling in appropriate quantities of at least nine chemical elements.* These must be built up into large molecules of peculiar composition and structure. Further, the cell must be organized into nuclear material, cytoplasm, centrosomes or their equivalent, and plastids. Since animals depend on plants for their supply of carbon, the earliest organisms would appear to have been plants equipped with chlorophyll grains for decomposing carbon dioxide.† No simpler forms of life have survived, or, as far as we can see, would have been able to carry on vital functions. Such complex energy-transformations require a complex machine. It is in the light of these

* Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, iron, potassium and magnesium; calcium is also necessary in many cases.

† The nitrogen-oxidizing bacteria recently discovered can work without chlorophyll. Other examples may be found, and this might prove to have been the earliest type of organism. But their organization is quite as complex as that of chlorophyll-bearing cells.

facts that we must approach the question of the source of terrestrial life.

Spontaneous generation has been a favorite hypothesis. But the experiments of Pasteur and Tyndall have proved that, on our present earth, when germs of previous life are rigidly excluded, there is no spontaneous generation of life, at least "under the conditions of the experiment." In other words, there is no evidence for spontaneous generation and considerable evidence against it.

The "radiobes" discovered by Burke a few years ago, in sterilized bouillon subject to the action of radium, were claimed as occupying a position between crystals and bacteria. They probably are to be explained as mere coagulations; radium is known to be destructive of all forms of life. Enzymes, though subject to some of the same conditions as living cells, are merely chemical compounds; they cannot be considered as simpler forms of cells. They are not living creatures any more than are proteids or carbohydrates. Centrosomes, plastids, etc., have a more or less independent existence, but only as parts of the living cell.

"Experimental abiogenesis," says Loeb, "is the goal of biology." The majority of present-day scientists are working on the assumption that, when we have learned enough about the chemistry and behavior of the cell, it will be possible to build up a living cell artificially in the laboratory. We have seen that Emil Fischer has gone as far as constructing a simple colloid. If Fischer or his son or his grandson succeeds in building peptides into peptones, and peptones into albumins, and albumins into cells, it is by no means certain that the cell-machine so constructed would show the characteristics of a living organism. To this question I shall return a little later. My present point is that the casual assembling, even of the materials necessary for an albumin molecule, is almost inconceivable. Once assembled, the possibility of their happening to fall into the proper arrangement is cut off by the doctrine of chances. In the albumin molecule we probably have to do with nearly a thousand atoms. The science of stereo-chemistry shows that these are arranged in definite groupings, not merely mixed like grains of sand. Any one with a mathematical bent and unlimited blackboard facilities may figure out the chance of an adequate supply of five kinds of atoms falling into the arrangement $C_{239}H_{386}N_{58}S_2O_{78}$ (egg-albumin.) The physical world never achieves even such comparatively simple compounds as the alcohols and amines. We must conclude, therefore, that the first organization, on this planet, of inorganic material into living cells, is explicable only on the supposition that life was, in some sense, already present in the universe.

It has been suggested that life may have reached us from some other planet, through the meteorites continually falling on the earth. Doubtless certain organisms might have survived the cold of such a transit. But, to quote from Chamberlin and Salisbury: "There is nothing in known meteorites, save perhaps the existence of hydrocarbons equally assignable to inorganic sources, to indicate that they came from worlds with atmospheres and hydrospheres suited to maintain such life as the problem presents. On the contrary, there are the best of grounds for believing that meteorites came from bodies in which the essential conditions of life were wanting; for, besides the absence of free oxygen and water, there is an absence of the products assignable to weathering and to those rock-changes that spring from the presence of an atmosphere and hydrosphere."*

The question of the existence of life on other heavenly bodies is essentially a biological one, and the best answer has been given by a biologist, the late Alfred Russell Wallace. The physical conditions necessary for metabolism he states as follows: "1. Regularity of heat-supply, resulting in a limited range of temperature. 2. A sufficient amount of solar light and heat. 3. Water in great abundance, and universally distributed. 4. An atmosphere of sufficient density, and consisting of the gases which are essential for vegetable and animal life. These are Oxygen, Carbonic-acid gas, Aqueous vapor, Nitrogen, and Ammonia. These must all be present in suitable proportions. 5. Alternations of day and night."†

These conditions the earth appears to have fulfilled throughout geologic times, thus allowing the chemical processes of metabolism to go on as at present. No other planet in the solar system fulfills these conditions,

* Geology, II, 112.

† *Man's Place in the Universe*, 3d ed., 1904, p. 205.

according to Wallace. Only Venus has the proper mass to retain an atmosphere and hydrosphere. But Venus (as also Mercury) probably always presents the same face to the sun, which means a great excess of heat on its face and a deficiency on its back. The larger planets, with their low densities, probably consist of permanent gases and do not have a solid surface.

As to Mars, the planet of strife, Wallace's statements must be revised in the light of recent evidence. Campbell has computed the density of the Martian atmosphere at less than one-fourth that of the earth, but Lowell questions the methods used. The Flagstaff Observatory claims to have found the spectroscopic line of water vapor, and the snow of the polar caps is now considered by most scientists to be frozen water rather than carbonic acid. As to temperature, earlier estimates neglected the blanketing effect of the atmosphere. Lowell computes the mean temperature as high as 48° F. Through most of the year intense cold undoubtedly prevails in all but the equatorial regions, and the alternations of day and night are more severe than on the earth. It is recognized by all parties to the debate that the equatorial regions must be desert, except for possible irrigation. Scientists are not agreed as to whether the oblique rays of the sun would be able to melt the polar caps, or whether the snow, under such a low atmospheric pressure, would not evaporate rather than turn to water. It is by no means certain that the "canals" represent belts of vegetation bordering on channels through which this polar water flows. The canals are straight and follow great circles. But even if the surface of Mars should prove to be perfectly level, it is hard to see why water should flow from the poles to the equator.

As to the further step in Percival Lowell's argument, that these canals must be *artificial,* the work of intelligent inhabitants, a scientific man should keep his imagination under full control. There is not the slightest evidence that the temperature, density, etc., of Mars were ever more favorable to life than they are at present. The planet has never had a larger mass, or been any nearer the sun. Taking the planet as it is now, and presumably always has been, the extremes of temperature are too great, the atmosphere too rare, and water too scarce for a free development of animal life such as we see on the earth, with constant mutation resulting at last in the evolution of capable engineers. Such an organic development on Mars is simply out of the question. Earthly evolution did not take place, and could not have taken place, on the Sahara or its oases. All we could expect on Mars would be some low vegetable forms. And plants do not build canals.

As to the habitability of planets outside the solar system, we have no evidence that such planets exist. Thus far our system is unique in astronomy. Central suns would also be required, stable enough for a sufficiently long period to furnish light and heat for planetary life-development. We must rule out the stars in or near the crowded Milky Way, where the average life of a star would be too short. Other stars must be ruled out as still in process of formation or rapid condensation, others as binary or multiple systems subject to intense tides. "In those remaining," as Wallace puts it, "whether they may be reckoned by tens or by hundreds we cannot say, the chances against the same complex combination of conditions as those which we find on the earth occurring on any planet of any other sun are enormously great."*

Wallace's argument against the habitability of any other heavenly body seems to me unanswerable, if we grant his assumption that the laws of biology are uniform and that life on other planets must necessarily conform to the conditions of life on the earth. These conditions appear to be partly physical and partly chemical. Only a certain planetary mass and temperature-range will retain the fundamental chemical elements and enable them to enter freely into combination. On other heavenly bodies there might be organisms made up of other elements and subject to other conditions. But then that would not be protoplasm. It would be something else, about which we know nothing and have no right to frame hypotheses. Here and in other parts of our inductive philosophy, a confession of ignorance must not be mistaken for a negation. We have no basis for a denial of other life-plasms any more than we have for an affirmation. We are simply beyond our depth.

Coming to solid ground again, it is clear that protoplasm on this planet—the only life-plasm we know—

* *Op. cit.*, 312.

conforms to physical laws and conditions. It makes part of the physical universe as at present constituted. More and more, organic processes are coming to be recognized as chemical in their nature. The cell is an energy-transformer. It is a physical machine, and as such is subject to physical (physico-chemical) stimulus and control. The same is true, to a certain extent, of the complex molecules out of which the cell is built. Protoplasmic molecules are essentially mechanisms. The total quantity of protoplasm varies with the number of cell-machines; it has greatly increased during biologic history and doubtless is still increasing.

We now return to the question: What is life? Of the current theories, only three are in any sense inductive and worthy of serious consideration. The first theory is that life is a form of energy, or, as one writer puts it, "the form of energy peculiar to living matter." Solar heat is transformed into electrical and atomic energy, and this into the "biotic" energy of the cell. This theory appears to me to be bad biology and worse physics. Life is quite distinct from kinetic energy, whose transformations it seems able to control. In these transformations, the total of the five physical energies is always constant. This has been repeatedly tested in the calorimeter. The life or death of the organism maks no difference in the total. A generally level-headed scientist says, however: "It is no argument against the existence of a discrete form of energy that it is only produced from other forms of energy and passes back again into other forms. In fact, it must be so produced and so pass back, or the balance of which the law of conservation is the expression would be upset."* This line of reasoning is like that of the man who pretends to transfer a coin from a cup to his mouth and back. We have not seen the coin meanwhile, but he picks up the cup and sure enough there it it is back again! Any of the five forms of physical energy may be added to or subtracted from the total, and so detected. Why does not biotic energy give some evidence of a separate existence? Life is *not* a form of energy, any more than it is a substance possessing mass and weight.

A second theory, now widely current, is that life is merely the sum total of the physical processes which go on in the cell, just as oxidation, for instance, is the act of union between atoms of oxygen and the atoms of some other element. If there is no such union of atoms, there is no oxidation. If the organic processes cease, there is no life. It is certainly true in this case that there is no evidence for life. This theory commends itself at first by its simplicity. But it is too simple: it is a label for certain processes, not an explanation of them. It offers no clue to the origin of life on this planet. All organic phenomena depend on "that which" organizes inorganic elements into the complex machine known as the living cell. One such machine seems capable of perpetuating itself in an unlimited

* Benjamin Moore, *Recent Advances in Physiology,* 6.

number of similar machines. But the chance aggregation of atoms and molecules into one such machine we have found to be unthinkable.

The most hopeful prospect is afforded by a closer study of the living cell as an energy transformer. When a plant cell, by means of its chlorophyll grains, under the stimulus of the sun's rays, breaks up a molecule of CO_2, rejecting one or both of the oxygen atoms and building the carbon atom into new combinations, the action of the cell resembles that of a physical force. That is, the cell appears able, like a force, to change the form and direction of physical energy. The process is very similar to that where the gravitation pull, with the help of a water wheel, transforms the energy of a stream into that of a mill; or where the electric force, by means of a carbon or metal filament, converts some of the kinetic energy of the electrons into the radiant energy of an electric light. Life resembles a physical force. It is not identical with any one of the physical forces; in fact it controls forces as well as energies.

According to the third theory, therefore, life is that which is able to organize inorganic material into a cell-machine, and, through a number of such organic machines, of constantly increasing complexity, to exercise further control over physical energies and forces. Life, as Sir Oliver Lodge expresses it, is "a guiding and controlling entity which reacts upon our world according to laws so partially known that we have to say they are practically unknown, and therefore appear in some respects mysterious."* Since this theory of the nature of life is the one suggested by the facts themselves, we may take it as a working hypothesis, to be confirmed or disproved by such further evidence as we may be able to glean.

The energies and forces controlled by life, through the machinery of protoplasm, are those which in their totality make up the physical universe. Life is evidently part of the same universe, so that we must now use that term in a larger sense, as embracing both energy and life. Whatever the exact source of life on this planet, there is life in the universe, interwoven in some way with the physical. The wider universe is able to produce or manifest the biological phenomena with which we are familiar. Since spontaneous generation is unknown and life always comes from some previous life, there is a strong presumption that life exists elsewhere in the universe, under different forms. "Whatever life may be, it is something which can begin to interact with the atoms of terrestrial matter at some period or state of aggregation or other condition of elaboration,—a condition which may perhaps be rather definite, if only we were aware of what it was." This is another quotation from Lodge in his answer to Haeckel.† But Haeckel's monism seems to me to aim for this same point, though he blunders upon many dogmatic and foolish statements by the way. It is in order now to call for the question laid on the table

* *Life and Matters,* 1905, p. 117.
† *Id.,* 91.

earlier in the chapter—whether an artificial cell, if we ever succeed in assembling one, would show the characteristics of a living cell. In other words, would it live? Is life constantly passing through our world like a series of electric waves, ready to set in vibration any instrument that is tuned to receive them? We do not know. We can only answer: "Try it and see."

The general question, how far life, as distinct from protoplasm, is subject to the physical categories, is too abstract to discuss here. On one point, however, the problem of the individual, we touch the concrete. In default of any knowledge of smaller units, we may take the cell as the biological unit of number. But the unit of life is not the cell but the individual organism. In some cases the two are identical. A protozoan cell, for example, is one unit of protoplasm; it is also one organism, one life. When it divides, it becomes two units of protoplasm and two organisms. So with the ovum and spermatazoön of a higher animal, which are two cells and two organisms, until they coalesce to form one cell, one organism. Every individual organism comes from some previous individual, just as every cell comes from some preëxisting cell. When the fertilized egg-cell divides, however, we have two cells, two units of protoplasm, but only one organism. The two together form a unity, as will be described more fully at a later point. However much the cells may multiply by division, or change the material of which they are composed, the organism continues to be one. It also continues apparently to be the same. It remembers, in a biological sense, its own previous life, as well as that of its ancestors. When the individual organism dies, it apparently ceases to be, as suddenly and completely as it began to be in the fertilization of the germ. This appearance and disappearance may conceivably be merely apparent.

Many questions might be raised in this connection. Even in the higher organisms the individual cell maintains a certain independence. After the death of the organism many of these cells persist for a limited time before dying, that is turning to water and breaking up into simpler elements. During this temporary persistence should the cells be termed organisms? At the Rockefeller Institute, Carrel and Burrows have succeeded in taking out one of the kidneys of a dog, treating it, and replacing it after an interval of fifty minutes. They have proved that a segment of artery can be kept in cold storage in a condition of latent life, and then successfully transplanted to another organism, perhaps of a different species.* During that fifty minutes or during that cold storage process, were the kidney and the artery individual organisms? They have been part of an organism, and may be again, just as a piston-rod temporarily removed from an engine is part of an engine. But a specialized animal cell or tissue is not able to perpetuate its life for an indefinite peiod, either through metabolism or through reproduction. On the other hand, any toti-potent cell detached from

* *Journal of Experimental Medicine,* March, 1910, April, 1911.

a plant may, under proper conditions, become an independent organism.

Without stopping longer on these rather academic problems, it seems safe to conclude that, in addition to the category of number, and the general category of unity (as making part of the universe,) all normal living creatures are characterized by individuality, a sort of "dynamic unity" of the individual organism. This should be included with the four biological categories given at the close of the last chapter.

By life, to analyze this concept in its turn, we mean the individual lives which are represented by the organisms on our earth, and the life or lives which may exist in the universe under other forms. What life is in itself, apart from organism, we do not know. Biology, as the science of organism, can never tell us.

Does the gradual perfecting of species imply plan and purpose in the universe? It might imply that; such a view would be entirely consistent with the facts. On the other hand, the perfecting of species might be due to the normal action of organisms, especially under the categories of variation and regeneration. We may expect to learn considerably more about these factors. But an answer to the question of purpose is beyond the scope of biology today, and probably always will be. It is hard to see what extension of our present biological knowledge would lift us from our position of agnosticism.

What then is the contribution of biology to philosophy? The universe is not merely physical; it includes the phenomena of life. And since life is able, to a certain extent, to control physical energies and forces, without altering their quantities or the laws of their behavior, we have clear evidence that there is some such control of the physical side of the universe.

The psychical sphere of phenomena may give us further light. The interpretation of life, like life itself, is inseparably connected with mind, which is its other phase or its accompanying factor.

PART III

THE PSYCHICAL

CHAPTER X

THE EVOLUTION OF MAN

MENTAL phenomena are not, strictly speaking, supernatural to biology. The distinction between life and mind is largely for convenience. No settled boundary line can be drawn between the biological and the psychological group of sciences.

On entering the broad field of psychology, our first task is to complete the story of organic evolution. Thus far we have referred to man only incidentally. Four lines of evidence teach us that the human species has evolved from lower forms of life.

(a) *Comparative Anatomy.* In anatomical structure man belongs to the animal kingdom, to the branch vertebrates, to the class of placental mammals, to the order primates, and to the sub-order anthropoidea. That is, man not only resembles in structure and organs all vertebrate animals and especially all mammals (so much so that one of the best ways of studying the human body is by dissecting a cat or a rabbit) but he shows an unmistakable connection also with the lower and higher apes.

The most important characteristics of the primates are the well-developed pelvis and rear limbs, enlarged big toes, nails instead of claws, a complete collar-bone, a disk-like placenta, enamelled teeth of all four kinds, whose number and arrangement are almost invariable, and special developments or tendencies of brain and skull.

The anthropoidea are characterized by the size and convolution of the cerebral hemispheres and by the single pear-shaped womb. Of the members of this order, the catarrhine (narrow-nosed) apes of the Old World have nostrils resembling those of man, and the same dentition, twenty milk teeth and thirty-two permanent teeth. The New World apes show slight differences.

Man appears to be descended from some extinct member of the catarrhine branch. The living forms of the latter are divided into tailed and tailless apes. The tailless apes of the present day, such as the orang-outang of Asia and the gorilla and chimpanzee of Africa, resemble man in minor points of structure, in size, in brain-development, and in the tendency to walk erect. It is hard to say which of the apes mentioned is nearest to man. Each shows special points of resemblance. The structural and organic differences between man and what we might term the composite tailless ape are slight, aside from features which are apparently connected with higher brain development. Huxley's statement has never been seriously disputed: "The structural differences which separate Man from the Gorilla and the Chimpanzee are not so great as those which separate the Gorilla from the lower apes."*

(b) *Embryology.* The human embryo, as it de-

* T. H. Huxley, *Place of Man in Nature,* 1863, American ed. p. 123.

velops from a single cell about 1/125 of an inch in diameter into the complex organism which we see in the babe, repeats, like other animals, some of the embryonic history of its ancestors. It first appears in a form resembling the protozoan amœba. This, by repeated subdivision, becomes in turn a "mulberry," a single cell-wall enclosing a fluid, and a gastrula or two-layered stomach-pouch much like the hydra. All metazoa pass through these stages, and while doing so are practically indistinguishable from each other. The human embryo from now on might properly be classed, at successive stages, with the embryonic or typical forms of the vermes, the tunicates, the primitive vertebrates such as the amphioxus, the primitive fish forms, the amphibians, the primitive or typical mammals, the tailed catarrhine apes and the tailless catarrhines. The evidence should be studied in the laboratory. In its details the recapitulation is abbreviated and foreshortened; the evolutionary history is often obscured by features due to the adaptation of the fœtus to the conditions of its own embryonic development. But the main outlines are unmistakable, even to the development of some useless features, such as hair-coat and tail, which must be eliminated before birth.

(c) *Rudimentary Organs.* Survivals are found in man, as in all higher animals. Examples are the vermiform appendix, of positive harm to man but useful to many herbiverous animals, where it is of large size; muscles for twitching various parts of the skin, still used by man for drawing up the eyebrows, but rudimentary in other parts of the body, except with certain individuals; similar muscles for twitching the external ear; a small blunt point on the edge of the ear-fold which represents the point of a primitive pointed ear; from three to five bones of a rudimentary tail, and occasionally rudimentary muscles for moving it; the grasping power of a new-born babe and the angle at which the soles are set, resembling characteristics of the arboreal apes; the semi-lunar fold of a third eyelid, found in use among many animals, even some mammals; the hair on the body, which is no longer of any value to man, and the direction of the hairs toward the elbow on both the upper and lower arm, an arrangement found only in the higher apes and a few American monkeys. The list of rudiments might be greatly extended, especially if we included abnormal human features, which are generally reversions to ancestral types.

(d) *Comparative Psychology.* It is often thought that there is a break between the mental development of man and that of the higher animals. This is true only in the same sense that there is a break between the development of an adult and that of a child.

In the first place, man is a true anthropoidea in brain and nervous system, as in the other points of his anatomy. The resemblance extends even to convolutions and fissures, and to the localization of function. Our knowledge of the human nervous system has been gained largely through experiments on monkeys. Man is simply the culmination of a long evolution, which begins with the protozoan cell, sensitive as a whole to external stimuli, passes through the rudimentary nervous systems of invertebrates, already in many cases showing specialization into sensory and motor centers, and finally reaches the segmented nervous system characteristic of all vertebrates.

In the second place, the psychological evolution corresponds with that of the nervous system, and man is a true anthropoidea in his mental processes, as far as a comparison is possible. This subject has already been touched on in a crude way in our first chapter.* The best recent work has been along the line of a more careful observation of the behavior of animals. Earlier students, like Romanes, relied largely on random anecdotes, and even in their interpretations of these they were often led into anthropomorphism.

Special reference should be made to the comparative psychology of lower forms of life, a subject on which there has been a good deal of careless observation and less reasoning. Some writers have attributed to micro-organisms a mental life that is astonishingly advanced —almost human. But Professor H. S. Jennings has made a very thorough study of the behavior of one of the common infusoria, the paramecium, and finds no actions that cannot be classed as merely organic. The taking of food is automatic, being due to the water currents set up by the cilia. There is no selection of food material by the organisms. They are repelled by alkalies, cold, or great heat, and attracted by certain acids, especially by carbon dioxide. Since the parame-

* See p. 13 *ff*.

cia, like all animals, excrete CO_2, which finds its way into the water, the more paramecia massed together the more CO_2 and the more attraction. This is undoubtedly the explanation of the so-called social phenomena of these animals. They do not profit by experience. There is no choice in the matter of their own movements. For all classes of stimuli, they first reverse the cilia and swim backward, then turn and swim forward. The turning is always toward the side opposite the mouth opening.*

Probably the psychological development of the paramecium would be typical of the entire plant kingdom and of all animals until the rise of a simple nervous system. The only psychic life is that represented by the processes which I have given as characteristic of all organisms.† The value of nerves, as Professor Loeb says, "lies in the fact that they are quicker and more sensitive conductors than undifferentiated protoplasm. Because of these qualities of the nerves, an animal is better able to adapt itself to changing conditions than it possibly could do if it had no nerves. Such power of adaptation is absolutely necessary for free animals."‡

For the higher stages of psychic evolution I may quote Professor Thorndike's summary of his own studies. "Experiments have been made on fishes, reptiles, birds and various mammals, notably dogs, cats, mice and monkeys, to see how they learned to do cer-

* *Psychology of a Protozoan*, in *American Journal of Psychology*, X, 503 (1899).

† See *ante*, pp. 128 *ff*, and the discussion of tropisms, p. 119.

‡ *Comparative Physiology of the Brain*, 5.

tain simple things in order to get food. All these animals manifest fundamentally the same sort of intellectual life. Their learning is after the same general type. What that type is can be seen best from a concrete instance. A monkey was kept in a large cage. Into the cage was put a box, the door of which was held closed by a wire fastened to a nail which was inserted in a hole in the top of the box. If the nail was pulled up out of the hole, the door could be pulled open. In this box was a piece of banana. The monkey, attracted by the new object, came down from the top of the cage and fussed over the box. He pulled at the wire, at the door, and at the bars in the front of the box. He pushed the box about and tipped it up and down. He played with the nail and finally pulled it out. When he happened to pull the door again, of course it opened. He reached in and got the food inside. It had taken him 36 minutes to get in. Another piece of food being put in and the door closed, the occurrences of the first trial were repeated, but there was less of the profitless pulling and tipping. He got in this time in 2 minutes and 20 seconds. With repeated trials the animal finally came to drop entirely the profitless acts and to take the nail out and open the door as soon as the box was put in the cage. He had, we should say, learned to get in.

"The process involved in the learning was evidently a process of selection. The animal is confronted by a state of affairs or, as we may call it, a 'situation.' He reacts in the way that he is moved by his innate nature or previous training to do, by a number of acts. These acts include the particular act that is appropriate and he succeeds. In later trials the impulse to this one act is more and more stamped in, this one act is more and more associated with that situation, is selected from amongst the others by reason of the pleasure it brings the animal. The profitless acts are stamped out; the impulses to perform them in that situation are weakened by reason of the positive discomfort or the absence of pleasure resulting from them. So the animal finally performs in that situation only the fitting act.

"Here we have the simplest and at the same time the most widespread sort of intellect or learning in the world. There is no reasoning, no process of inference or comparison; there is no thinking about things, no putting two and two together; there are no ideas—the animal does not think of the box of the food or of the act he is to perform. He simply comes after the learning to feel like doing a certain thing under certain circumstances which before the learning he did not feel like doing. Human beings are accustomed to think of intellect as the power of having and controlling ideas and of ability to learn as synonymous with ability to have ideas. But learning by having ideas is really one of the rare and isolated events in nature. There may be a few scattered ideas possessed by the higher animals, but the common form of intelligence with them, their habitual method of learning, is not by the acquisition of ideas, but by the selection of impulses.

"Indeed this same type of learning is found in man. When we learn to drive a golf ball or play tennis or billiards, when we learn to tell the price of tea by tasting it or to strike a certain note exactly with the voice, we do not learn in the main by virtue of any ideas that are explained to us, by any inferences that we reason out. We learn by the gradual selection of the appropriate act or judgment, by its association with the circumstances or situation requiring it, in just the way that the animals do.

"From the lowest animals of which we can affirm intelligence up to man this type of intellect is found. With it there are in the mammals obscure traces of the ideas which come in the mental life of man to outweigh and hide it. But it is the basal fact. As we follow the development of animals in time, we find the capacity to select impulses growing. We find the associations thus made between situation and act growing in number, being formed more quickly, lasting longer and becoming more complex and more delicate. The fish can learn to go to certain places, to take certain paths, to bite at certain things and refuse others, but not much more. It is an arduous proceeding for him to learn to get out of a small pen by swimming up through a hole in a screen. The monkey can learn to do all sorts of things. It is a comparatively short and easy task for him to learn to get into a box by unhooking a hook, pushing a bar around and pulling out a plug. He learns quickly to climb down to a certain place when he sees a letter T on a card and to stay still when he sees a K. He performs the proper acts nearly as well after 50 days as he did when they were fresh in his mind. This growth in the number, speed of formation, permanence, delicacy and complexity of associations possible for an animal reaches its acme in the case of man."*

Some further discussion of these subjects will be given later. The present chapter is intended to be largely in the nature of a summary.

What really distinguishes man from his cousins of the higher anthropoidea? Physiologically the differences are slight. Every bone and organ could be distinguished from the corresponding bone or organ of a gorilla, but the same is true of a gorilla as compared with a chimpanzee. The individuals of a species are specifically different in practically all details from the individuals of every other species.

The distinguishing differences between man and the higher apes may be enumerated as follows: (a) An immense increase in intelligence. Among the most striking manifestations of this are the power of acquiring language, and the power of using tools, fire and clothes. (b) Increased size of the brain. In a healthy human adult the brain never weighs less than thirty-one or thirty-two ounces, the average is about forty-eight among males and sixty is often reached. The gorilla brain never weighs more than twenty ounces, although the total weight of the gorilla is very much

* Edward L. Thorndike, *Pop. Science Monthly,* Nov., 1901; reprinted in *Animal Intelligence,* p. 282 *ff.*

greater than that of man. "An average European child of four years old has a brain twice as large as that of an adult gorilla." The increase is chiefly in the cerebral hemispheres, which also show greater number and irregularity of convolutions. It should be stated, however, that there is no direct connection between brain-weight and mental capacity.* (c) A prolonged period of helpless infancy in the human species. (d) Man stands and walks erect, with flat soles and the legs longer than the arms. (e) Increased control of the voice, which makes possible the articulate speech so characteristic of the species. This power may be connected with the upright head. (f) Man is comparatively hairless.

It is not easy to determine the relation between these factors. In the present state of our knowledge, we must consider the various physical factors—brain-weight, upright stature, power of speech, and absence of hair—not as characteristics acquired and transmitted, but as a series of mutations. We have analogies from zoölogy to show that such mutations (each of them involving several physical factors) must have occurred at irregular intervals, along with countless other mutations that have not survived.

Of the factors named, only the power of speech would appear to be at all fundamental. Whether this was primary and the increased intelligence secondary or *vice versa,* is at present a matter of mere speculation. The origin of human intelligence is only another side

* *Cf.* William H. Thomson, *Brain and Personality,* New York, 1908, p. 49 *ff.*

of the problem of increased intelligence in other species. In the later stages of evolution, wits proved themselves of more value than strength. A specialization of wits once started, each mutation that was of any possible service along this line would at once gain a foothold and tend to become permanent. With a more complex nervous system, a prolongation of infancy became necessary. This in its turn reacted in various ways—physical, mental and social—but Fiske was probably mistaken in making it a primary factor.

The social instinct has undoubtedly been a powerful factor in animal evolution. Coöperating animals were able to secure a better food supply and better protection. Association developed intelligence in the individuals. Among the higher animals, the most intelligent are those especially social, such as the ants, parrots, and monkeys; the only striking exception is the carnivora. The higher apes are exceedingly gregarious. They hunt and fight together, communicating by rude sounds. They have begun to acquire such habits as using sticks and stones and building shelters.

Probably Professor Giddings does not overstate the fact when he says that "association, more extended, more intimate, more varied in its phases, than the association practised by inferior species, was the chief cause of the mental and moral development, and of the anatomical modifications that transformed a sub-human species into man."* The expenditure of surplus energy in play has been carried farthest among the primates.

* Franklin H. Giddings, *Principles of Sociology*, 1896, p. 221.

Among even the most primitive men play has become organized in festivities and games. "The development of association in intimacy, and above all, the development of festivity, converted the elementary language of animals into speech, which was thenceforward the foundation of human progress."

Let us glance next at the question of the antiquity of the human species. The fullest evidence is that from Europe, where recent years have seen a great advance in both the material and the methods of prehistoric anthropology. It is now customary to divide the Stone Age into the Eolithic, the Paleolithic, and the Neolithic Periods.

Let us consider these periods in reverse order. The Neolithic may be defined as that section of the Stone Age which overlaps the present geological period. Climate, fauna and flora were practically what we know today, and the surface of the earth up to the Arctic Circle was open to man's habitation. Greater skill is shown in the shaping of tools and weapons, which are frequently polished. Arrowheads indicate the general use of the bow and arrow. Pottery and weaving are known; also agriculture and the domestication of animals. The Neolithic Period is of comparatively short duration. In Switzerland, for example, it covers approximately from 5,000 B. C. to 1,500 B. C., when the Bronze Age reaches the Alps.*

The Paleolithic Period is considered by recent writers

* *Cf.* G. G. MacCurdy, *Recent Discoveries Bearing on the Antiquity of Man in Europe,* Smithsonian Report, 1909, p. 546.

as co-extensive with the middle and upper levels of the Pleistocene (Quarternary). Arctic conditions prevailed in Europe, alternating with periods of less severe climate. Mèn were present in this epoch, spreading northward after each withdrawal of the ice and leaving evidence of their culture in caves and valley deposits. (The current sub-divisions of the Paleolithic cannot be discussed here.) They were contemporaries of extinct or migrated animals, such as the bison, cave-bear, mammoth, reindeer and rhinoceros. Fire was known. Pieces of flint were chipped into tools and weapons, and others were ground from bone or horn. Skins were rudely stitched together for clothing. The art-work of Paleolithic man, as found in cave dwellings, especially in Spain and Southern France, is one of the wonders of History. Some of the sculpture is promising, and the drawing shows an observation, a sense of form and a freedom of execution that would have been creditable in any age.

The Eolithic Period (if such exists) covers geologically the lower Pleistocene, the Pliocene and the upper Miocene. The evidence is still in dispute. The question hinges almost wholly on the question of whether the chipped flints found in these levels are human manufactures or whether they are due to natural causes. I am inclined to feel that the supporters of the Eolithic theory are making good. Such a period seems to be demanded by the relatively high culture of the lowest Paleolithic levels. The natives of Tasmania are shown to have been on what is practically an Eolithic stage.

And Verworn has given figures to show that the chipping of the flints follows a definite purpose in too large a proportion of cases to be the result of accident.*

With the present uncertainty as to the duration of the geological periods, any figures given for the antiquity of man must be largely guesswork. If we accept Dana's estimate of 3,000,000 years for the Cenozoic Era, and make the arbitrary assumption that it is subdivided into five equal periods, of 600,000 years each,† the Paleolithic Age, covering about two-thirds of the Pleistocene, begins 400,000 years ago. An Eolithic Age, covering the upper third of the Miocene, would carry the antiquity of man back to 1,400,000 years.

There is the same uncertainty as to the period when we should look for the series of mutations resulting in the human species. During the Pleiocene, Northern Europe was still covered by water and Central Europe was becoming too cold for the primates. During most of the time from the Eocene to the Miocene Period, the slowly-evolving anthropoidean hordes might have had for their range a tropical or semi-tropical belt stretching across Europe and Asia from England to

* *Zeitschrift für Ethnologie,* XL, 548 (1908). See also summaries by MacCurdy, *American Anthropologist,* new series, vol. 7, p. 425 (1905), and *Proceedings of Am. Assoc. for Advancement of Science,* vol. 56 (1907). Recent discoveries are reported from Boucelle, Belgium, in Oligocene deposits. The correctness of this identification, it seems to me, is extremely improbable and cannot be accepted without further evidence; no trace of the anthropoidea has yet been found before the Miocene.

† Eocene; Oligocene; Miocene; Pleiocene; Plestocene, including Present.

Java, and sometimes including parts of Africa north of the Sahara. It is to this region that we should look for possible links between man and lower forms. Only three links have thus far been discovered. The first is the *pithecanthropos erectus* ("erect ape-man,") discovered by Dubois in Java in 1890 in Pleiocene (Volz and other authorities say Pleistocene) deposits. The brain is about two-thirds as large as that of the average man. This species resembles man more closely than the apes, though it is probably not directly in the line of human ancestry. The second is the transitional skull from Piltdown, Sussex (1912, probably Pleistocene.) The other is the jaw discovered in the Mauer sands near Heidelberg, which seems more nearly in the human line. No human remains from the Eolithic Period have yet been found. The famous Neanderthal skull, discovered near Düsseldorf in 1856, comes from the Paleolithic period. Many other skulls and skeletons are now known from this age. The earlier of these differ considerably from European skulls of the present day, giving us in fact a distinct type, the *homo primigenius*.

Although man constitutes one Linnæan species, there appears to have been constant mutation in his case as in that of other animals, producing many elementary species which have crossed and recrossed. The principal physical variations have been in relative breadth of skull, facial angle, cranial capacity, stature, comparative length of arms and legs, shape of nose, color of skin and of eyes, and color and texture of hair. All these points appear to be mutationary rather than acquired, except that stature and other elements of size are liable to increase with better nourishment.

Let us take Europe as an example. Scientists now distinguish three races, which overlap (because they long antedate) the present political and linguistic boundaries. These are the *Teutonic,* which is characterized by long heads, long faces, very light hair, blue eyes, tall stature, and narrow aquiline noses; the *Alpine* (Celtic), with round heads, broad faces, light chestnut hair, hazel-gray eyes, medium stocky stature, and variable, rather broad, heavy noses; and the *Mediterranean,* with long heads, long faces, dark brown or black hair, dark eyes, medium, slender stature, and rather broad noses. Prehistoric and historic skulls bear out the testimony given by the measurements of 25,000,000 soldiers and school children.

Anthropologists are fairly well agreed as to the history of these three races. The earliest people of Europe were extremely long-headed and were probably related to the African negroes. They are best represented today by the Mediterranean race. The Teutonic race appears to be merely a variation of this, its blondness, etc., having been acquired in the comparative isolation of the Scandinavian peninsula. Toward the close of the Stone Age, Europe was invaded by a broad-headed race of decidedly Asiatic affinities. They came by infiltration rather than by conquest. After overspreading most of Europe, this Alpine race was obliged in many places to recede. It is found most purely today in the mountain ranges. No direct connection can be established between race and culture.*

In mental capacity, educability and potential development of the brain there appears to be no real difference between the long-head and the round-head, or between savage and civilized man. As an example of this I cite the case of the Australian aborigines, generally acknowledged to be the lowest of existing savages (of those at least which show no signs of degeneration.) It has now been shown beyond dispute that this backwardness is due to lack of opportunity merely and not to lack of capacity. The following are among the instances cited by the Hon. J. Mildred Creed in an article in the Nineteenth Century:†

"A pure-blooded aboriginal was brought to New South Wales from Northern Queensland when a young boy, and was employed about a homestead in the country, going messages, making purchases at the stores in the neighboring town, in the care of the horses, milking cows, etc., and from time to time in assisting his master, who was a very good amateur blacksmith, at the forge. His employer assured me that he was in all mechanical work a most efficient assistant, showing much more thought and brightness than the average white boy, often making useful practical suggestions as to the best way of completing the task in hand."

"Another remarkable instance is that of a youth who,

* In connection with this and the preceding paragraph, see Wm. Z. Ripley, *Races of Europe,* 1899, and references.

† VII, 89 (1905).

when an infant of a few days, was rescued by Mr. Grant, a Scotch gentleman, a naturalist, from impending death, consequent on the killing of his mother in tribal hostilities in the Bellender Ker Ranges, on the northeast coast of Australia. He is now eighteen years old, having been brought up as their own child by his adopted parents in the neighborhood of Sydney, New South Wales. He speaks at will in pure grammatical English or in the broadest Doric Scotch, generally, however, only using the latter when exercising his very keen sense of humour in astonishing the Scotch officers and engineers of ships with whom he is brought in contact by his employment. He was near, if not *at* the head of the highest class in a large public school of some two hundred and fifty boys, on leaving which he has been employed in very large shipbuilding and engineering works in the draughting-room. He sketches with considerable taste and skill, and makes tracings of machinery, etc. He is learning 'the pipes' on a chanter, and, as far as I am capable of judging, plays Scotch music with considerable skill and much taste, beating time with his foot in true Highland style. He thoroughly enjoys the fun when puzzled Scots quietly ask his senior officers, 'where did ye get the black Scotchman?' The chief draughtsman under whom he is employed, tells me he fully holds his own with white boys of his age who have had the same opportunities."

"One instance within my personal knowledge is that of an aboriginal housemaid in Sydney who is employed at a private hospital. She does all her work thoroughly, can always be trusted to perform each duty on its allotted day, not missing corners or scamping in any way. She gets ready the patients' meal-trays in a tasteful manner without special supervision, and on occasion can properly cook a plain dinner of joint and vegetables, with a simple pudding, as directed. She is a great mimic, and has a keen sense of fun, but is exceedingly sensitive to any rudeness or slight, especially one relating to her race or colour, which is very black. She has been many years with the family in which she is employed, and attends Church and Sunday-school with enthusiastic regularity."

"A very general belief exists that the race is unable to count beyond the first few numerals, and this was possibly correct when they were untaught by association with a superior race. I submit, however, that it is only true so far as it relates to power of expression; they, in their wild state, having no need of exact higher numbers, had no words to indicate them, but now that the want is supplied by English numerals they are as well able to enumerate as the whites. It is no unusual thing for an aboriginal to count sheep running through a gateway with the strictest accuracy. This is no slight test, as will be acknowledged when it is pointed out that in Australia it is a very small flock which contains less than a thousand, and that ten thousand is not unusual."

Mr. Creed's entire article should be consulted, especially his discussion of the sexual factor as explaining the cases of relapse of aboriginals to barbarism. In conclusion he cites two classical facts from earlier writers. "A. shepherd, Adams, has taken to wife a native woman, who had been brought up at some settler's station and was partially educated. Adams could not read, and the black wife taught the white husband to read."*

"The inspection of the aboriginal school at Ramahyuck, in Gippsland, during the last eleven years gives a percentage of results higher than the other State schools in Victoria; and while no doubt this excellence is largely due to the skill and zeal of the gentlemen who taught them, it fairly shows that aboriginal children are at least equal to others in power of learning those branches of education which are taught in the State schools of Victoria. On several occasions of examination by a Government inspector the percentage of the Ramahyuck School was a hundred, a result unparalleled by any other school in the colony."†

The latter part of this chapter may be summarized as follows: The continued evolution of the human species, so far as it was physical, has been confined to points that are of no particular advantage. Probably there has been some degeneration, as in eyes and teeth. Mentally, there has always been considerable difference both in individual capacity and in tempera-

* Hale, *Aborigines of Australia.*

† James Dawson, *Australian Aborigines,* 1881. *Cf.,* for the Maoris of New Zealand, the Report of the Registrar-general, as summarized in *Nature,* XL, 634 (1889). Similar evidence could be drawn indefinitely from the records of government and mission schools in various parts of the world.

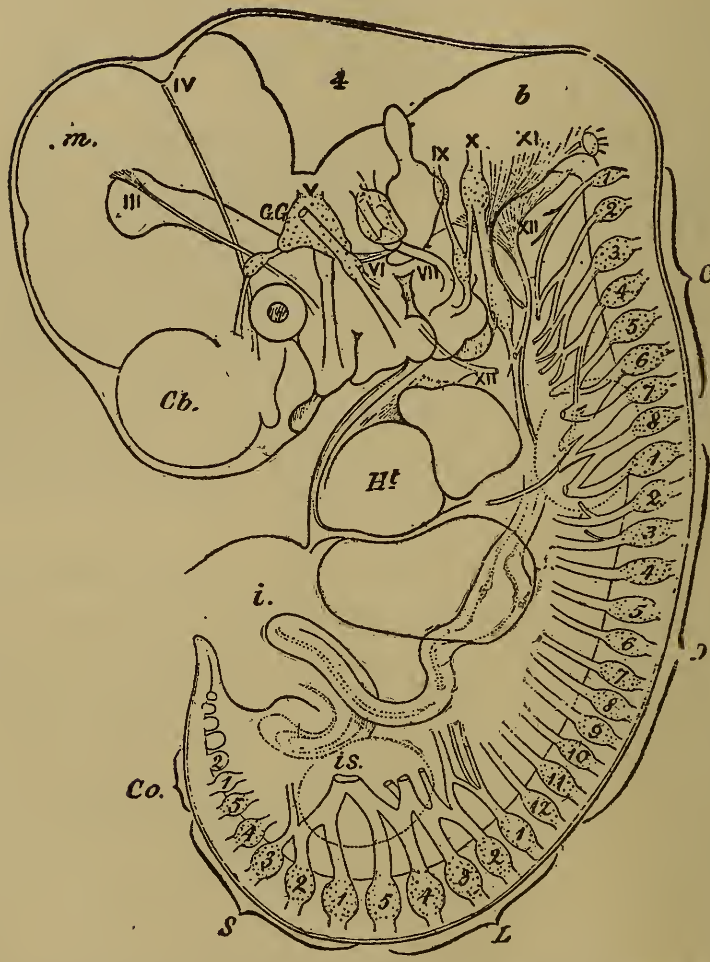
ment, as in all higher animals. To some extent these differences may be inherited. But the psychological mean of the human species has remained practically the same. Whatever the shape of our skull, color of our skin or cross-section of our hair, we start at birth where our human ancestors have started for countless ages.

CHAPTER XI

THE CENTRAL NERVOUS SYSTEM

WE now pass to a more detailed study of the human nervous system and its functions, with such further references to comparative anatomy as may be necessary. The reader is reminded that in this and the following chapter we are dealing almost exclusively with physiology—with the activities of a physical machine. In Chapter XIII we shall return to psychology, the study of the mental product or accompaniment of that machine.

It will be well at the start to review briefly the principal parts of the vertebrate nervous system. In the embryo a central groove or canal appears, parts of the front end growing rapidly and forming the three primary brain cavities. These in turn form the five regions of the adult brain. The first cavity gives rise to the two cerebral hemispheres, united by bridges and ending in the olfactory lobes, which connect by special (sensory) nerves with the nostrils. From this cavity also come the ganglia known as the optic thalami, connecting with the eyes by optic (sensory) nerves, which cross and interlace. The second cavity becomes the corpora quadrigemina (optic lobes) and some minor parts; from this region pass two other sets of (motor) nerves, connecting with eye-muscles. The third cavity



DEVELOPMENT OF THE VERTEBRATE NERVOUS SYSTEM*
Human embryo. *His.* Showing the peripheral nerves.

*From *The Structure and Functions of the Brain and Spinal Cord.* Charles Griffin & Co., L't'd, London. (1892.)

gives rise to the cerebellum, or little brain, and to the medulla oblongata, or extension of the spinal cord, from which pass six other pairs of cranial nerves, partly sensory and partly motor, reaching the remaining eye-muscles, the jaws, the ears, the skin and the body organs.

The rest of the primitive canal forms the spinal cord, which, like the brain, is bilateral and composed of both gray and white matter. The spinal cord gives rise to a number of pairs of nerves, usually reckoned in man as thirty-one, serving the limbs and other body parts (eight for the neck and arms, twelve for the thorax, five for the region of the loins, five for the legs and one for a tail). Each nerve has both a sensory and a

---

Development of the Vertebrate Nervous System

III to XII = The cranial nerves in order from the third to the twelfth.
Cb = Developing cerebral hemispheres.
m = Mid brain.
4 = Fourth ventricle.
b = Commencement of bulb, or medulla oblongata.
C (1 to 8) = The cervical nerves and ganglia on their posterior roots.
D (1 to 12) = The dorsal nerves and ganglia on their posterior roots.
L (1 to 5) = The lumbar nerves and ganglia on their posterior roots.
S (1 to 5) = The sacral nerves and ganglia on their posterior roots.
Co (1 to 2) = The coccygeal nerves and ganglia on their posterior roots.
Ht = Ventricle of heart.
i = Intestine.
is = Sciatic nerve cut at its origin.

motor root. In general, the cerebro-spinal nerves cross, those on the right side serving the left side of the body, and *vice versa.*

What are the functions of these various parts of the central nervous system? The spinal cord may be considered as an unspecialized or less specialized region of the original nervous canal. It continues to be a somewhat independent center of activity. Suppose one-half of the cord is cut. There ensues, for the region affected, paralysis of voluntary motion on the side of the body where the cut is made, and paralysis of perceived sensation on the opposite side of the body. This simply means that communication is cut off between these parts of the body and the brain centers governing volition and perception. The motor and sensory roots of each nerve serve opposite sides, explaining the cross effect. This lesion of the cord, however, does not seriously affect reflex action in the parts of the body apparently paralyzed. The cord may be completely severed, and still reflex action goes on in the region below. If the sole of a paralyzed leg is tickled, a stimulus is carried by the proper sensory nerve to a certain center in the cord; this transmits the stimulus to certain motor nerves controlling the muscles, and the leg is thrown into active movement, of which the person has no sensation and which he is absolutely unable to control.

Passing to the medulla oblongata, we see the same general phenomena as in the spinal cord, of which it is the extension. Like the cord, it is both a path of communication from the higher centers to the rest of the body and an independent center, mechanically controlling nervous processes which are essential to life. In the medulla originate most of the nerves to and from the sense and body organs. A babe born without any brain parts above the medulla will suck and swallow as well as does the perfectly-developed child. In both cases the introduction of the nipple stimulates certain nerves and the stimulus is transmitted to the proper centers in the medulla and thence distributed to the motor nerves governing the complex operations of sucking and swallowing. Similarly, normal action of the lungs and heart may go on as long as the medulla oblongata is intact.

We take up next the regions of the cerebellum, optic thalami and optic lobes. A frog deprived of its cerebral hemispheres is able to maintain its equilibrium and resists all attempts to disturb it. "If its foot is pinched, it will hop away. If it is thrown into the water, it will swim until it reaches the side of the vessel, and then clamber up and sit perfectly quiet. . . . If placed in a vessel of water, the temperature of which is gradually raised, it will not quietly submit to be boiled like a frog which has only its medulla and spinal cord, but will leap out as soon as the bath becomes uncomfortably hot. . . . There is a method in its movements. If an obstacle be placed between it and the light of a window, the frog will not spring blindly against the obstacle when its toe is pinched, but will clear it or spring to the side. It will alter the course of its leap according to the position of the obstacle between it and the light. There is, so far, no difference between its behavior and that of a frog in full possession of all its faculties. But yet a very remarkable difference is perceptible. The brainless frog, unless disturbed by any form of peripheral stimulus, will sit for ever quiet in the same spot, and become converted into a mummy. All spontaneous action is annihilated. Its past experience has been blotted out, and it exhibits no fear in circumstances which otherwise would cause it to retire or flee from danger. It will sit quite still if the hand be put forth cautiously to seize it, but will retreat if a brusque movement is made close to its eyes. Surrounded by plenty, it will die of starvation; but, unlike Tantalus, it has no physical suffering, no desire, and no will to supply its physical wants."* Some of the details of this classic picture are now known to be extreme. The brainless frog, on recovering from the shock, shows some power of memory and of spontaneous action.

This experiment is not easy to duplicate in the higher vertebrates, where the size and importance of the cerebrum are so much greater that its removal causes more or less complete prostration. Goltz, however, succeeded in removing the cerebral hemispheres of a dog and keeping the animal alive for years. Professor Loeb has thus summarized the result of the experiments: "In such a dog all those reactions in

* David Ferrier, *Functions of the Brain,* London 1886, p. 109.

which the associative memory plays a rôle are lacking permanently, while the simple reactions that only depend on inherited conditions remain just as in pigeons and in other animals."*

In man we know that equilibrium and locomotion may be maintained while the cerebral hemispheres are occupied in other directions. The lower regions of the brain are the seat of certain mechanical nervous reactions—that is, reactions which have become mechanical through constant (conscious) repetition in a particular direction. However much the way may be prepared through inheritance, the child must learn to stand and to walk. These regions are also the seat of reflex manifestations of feeling. When chloroform is administered, the cerebral hemispheres are first affected. Until the lower centers are reached, the situation is a good deal like that in removing the brain of the frog. Stimuli which ordinarily excite the feeling of pain merely excite the physical accompaniments of pain, such as groans and cries, without any feeling whatever.

By a process of elimination we have learned that the cerebral hemispheres are the seat of sensation, volition and all the conscious mental activity of man. This is true of all vertebrates, the upper brain being specialized as the organ of "consciousness."

In the cortex, or rind, of the cerebral hemispheres, we are able to map out the regions where special groups of sensory and motor nerves terminate: the visual area, the auditory area, the areas governing mus-

* Loeb, *Physiology,* 246.

cles of throat, arms, fingers, trunk, etc. Stimulation of motor regions brings the corresponding muscles into play. Injury to motor or sensory regions causes paralysis of volitional control or perceived sensation for the part of the body affected.

When this mapping is done, about two-thirds of the surface of the brain is left, including patches which isolate the different sense-areas. What is the significance of this large unmapped region, sometimes carelessly called the "silent area" of the brain? The increased cortical surface in man is largely in these areas.

Flechsig's theory, based on anatomical study, is that these are "association centers of the cerebral cortex," which, "receiving conduction fibres from adjacent sense centers and from adjacent as well as distant association centers, furnish an anatomical mechanism, which makes possible the working up into higher units of simple sense impressions and of combinations of simple sense impressions of the same quality and of different qualities."*

Some confirmation of this theory is given by modern studies in "aphasia," a disease due to injuries in the areas of the brain which have come to be associated with written or spoken speech, man's most distinguishing power. Physiologists have been slow to recognize this evidence, which seems to me incontrovertible. This has probably been because, in the nature of the case, the evidence could not, like other facts of local-

*L. F. Barker, *The Nervous System,* New York 1899, p. 1073.

ization, be confirmed by experiments on the animal brain. Practically the same arrangement of sensory and motor centers is found in the monkey as in the human brain. Paralysis of these centers leads to the same results in either case. But aphasia is unknown in the monkey because "phasia" is unknown; he has never learned to talk in any real sense.

The various speech areas of the cortex have become association centers for object-seeing, word-seeing, word-hearing, object-hearing, music-hearing. Injury to any one of these areas is followed by partial or complete cessation of the corresponding function. The auditory or visual sense-areas may be intact, and still the patient be word-deaf or word-blind, or otherwise incapable. A man may see the members of his family and be unable to recognize them; he may be able to recognize objects, but printed words are nothing but a blur; he may be unable to distinguish the words which come to him through perfectly normal hearing-organs; he may lose all power of distinguishing sounds; he may be unable to recognize the most familiar tunes. All of these forms of aphasia are familiar to the brain specialist; all of them are due to blood clots or local injuries.

That the development of these speech areas is due to education is shown by the fact that only one hemisphere is affected, the left hemisphere in right-handed people, the right hemisphere in left-handed people. The other hemisphere may be injured or even destroyed, without the slightest evidence of aphasia.

Through constant practice in childhood, one of the hemispheres, the one related to the hand most used (that is, in the majority of cases, the right hand and the left hemisphere), has been educated for articulate speech. Cases are known of aphasia in children, accompanied by right-sided paralysis, where the children have afterward learned to talk again by educating the other hemisphere. This plasticity diminishes with age. There is some evidence that parts of these association centers of speech are educated in succession. We have, for example, the well-known case of word-blindness where a man could read Greek perfectly and Latin fairly well, but had almost completely lost his French and English.*

What chiefly distinguishes the human brain from that of the monkey or chimpanzee is not its size or convolution, but the fact that one of the hemispheres is chosen during the first few months and parts of its cortex developed as centers for auditory and later visual speech. Similarly, certain motor areas are educated to control the muscles of articulate speech, writing, typewriting, piano-playing, etc. Physiologically, this acquirement of new faculties appears to make no difference. The other hemisphere, for instance, shows equal development and the same general arrangement of nerve fibres.

"All truly volitional action," as Ferrier says, "is the result of education, the duration of which varies within extremely wide limits in different classes and

* Hinshelwood, *Lancet,* Feb. 8, 1902. Quoted by W. H. Thomson, *Brain and Personality,* 97.

orders of animals, and in respect to individual acts of volition in the same animal. At birth the human and monkey infant have no volition proper, but only the elements out of which it is evolved. The actions of the infant are at first limited to definite reflex response to definite external or internal stimuli, and to indefinite or general motor activity, conditioned not so much by any definite stimulus as by a natural tendency of the nerve centers to expend their surplus energy in action. . . . The conscious discrimination of a sensation as pleasurable, and its ideal persistence and tendency towards repetition as desire, and its association with things seen, smelt, or tasted, are affected long before the sensation, present or revived, is associated with any differentiated motor act for its accomplishment or realization. This latter is the result of happy accident, or of repeated trials and error. Though the child possesses in the motor centers of its cerebral hemispheres the potentiality of differentiated motor acts, the individual selection or excitation of any of these, in response to a present or revived sensation, requires the establishment, by education and repetition, of an organic nexus between the special sensory center or centers, and the special motor center. . . . Voluntary control is first established over those movements which are also most easily called into play by reflex stimulation. A child can voluntarily grasp with its fist long before it can raise its hand to its mouth, or put out its hand to lay hold of anything. . . . The rate at which the organic nexuses are established between the sensory and motor centers varies according to the degree of complexity and intricacy of the movements. Complex and intricate movements are longer in being acquired than those which are simple, and also reflex or already hereditarily organized. Hence the movements of articulation in combination with those of vocalization are longer in being acquired than those of the arms or legs."*

It is not necessary for us to follow further the education of the child's brain, since we as yet know little of the physiological processes involved. There is some evidence that the brain retains a certain plasticity or adaptability even in adults. The hemispheres are not interchangeable. If the "talking" lobe, for instance, is removed, the other hemisphere cannot be educated to take its place. If the patient lives, not only will parts of one-half of his body be paralyzed, but he will be an idiot, incapable of the higher mental processes. But within either hemisphere some substitution of function is possible. Professor Ladd has called attention to an operation by Dr. Harvey Cushing of Baltimore, in a case of paralysis of the facial nerve. Such an operation is known as anastomosis. Part of the lower end of the accessory nerve was connected with the upper end of the injured facial. Improvement was almost immediate, and at the end of two hundred and eighty-seven days, by the help of electrical treatment and exercise of the facial muscles before a mirror, the patient had regained almost complete control. One of

* Ferrier, *op. cit.*, p. 433.

three things must have taken place. Either there was a complete substitution of functions between the centers of the facial and accessory nerves, or hitherto unused nerve elements were equipped for employment in voluntary motor functions, or the old center, because of over-stimulation, had broken over into the new one.*

* Geo. T. Ladd, *Popular Science Monthly,* LXVII, 319, (1905).

CHAPTER XII

NERVE CELLS AND REFLEXES

FURTHER discussion of the central nervous system must be postponed until we have studied the nerve cells which compose it. I shall go into this subject in some detail, partly because the material is new to most of my readers and partly because of its importance for philosophy. The question before us is this: Is there anything in the structure of the human brain or in the activity of its component cells to explain the remarkable mental life of man?

The number of nerve cells in the adult human body has been roughly estimated at three billion.* These nerve cells, or "neurones" as they are generally called, are true cells. They have been studied by the methods of fixation and staining which have proved so fruitful in modern microscopic biology, and in all the essential points of structure and behavior are seen to follow the laws of cell life already described. The neurones are, however, more highly specialized than any other type of cell.

The most striking characteristic of neurones is the

* Donaldson, quoted by Barker, *Nervous System,* 42 note. Francke's estimate of the total number of cells in the human body, exclusive of the blood corpuscles, is given as 3,996,000,000,000. These figures are of some value in helping us realize the relative proportions of the two groups.

NERVE CELLS AND REFLEXES

TYPICAL NEURONE*

Motor cell, anterior horn of gray matter of cord. From human fœtus (*Lenhossek*): * marks the axone; the other branches are dendrites.

* From *A Text-book of Physiology,* 2nd ed. W. B. Saunders Co., Philadelphia.

outgrowths to which they usually give rise. These are of two kinds, either gray like the cell-body, or "white." The former, called dendrites, from their resemblance to the branches of trees, are coarse projections of protoplasm, running out from the cell-body in several directions, dividing and tapering. They may thus cover considerable space—sometimes a hundred times that of the cell-body. Their ends are free, though often in contact with the dendrites of other neurones, and possibly in some cases united by cell-bridges. Each type of nerve-cell has its own form of ramification.

The other sort of outgrowths, known as axones, come in some cases from the stem of the dendrite, but usually they are earlier in time and come directly from the cell-body. They are straighter and smoother than the dendrites. They branch but do not taper. Their length varies from a fraction of a millimeter to half the height of a man. The ends are free, though in contact with other axones and dendrites.

The axone, when not passing through other gray matter, is usually provided with a sheath, apparently for protection or insulation. This consists of a thick fatty layer (myelin) and a cellular layer. The myelin sheath is what is familiarly known as the white matter of the brain and nerves. This sheath is acquired by the axone, the date of acquistion apparently depending on its future location.

The chemistry of neurones appears to be more complex than that of any other cells. They contain a large amount of water—83-84 per cent in the adult brain cells—indicating great solubility and instability in the compounds. Of the solid matter, the principal groups are the proteins—about 50 per cent—and the lipoids, resembling fats. In metabolism, the cell-bodies are served as usual by the blood and lymph.

The nutrition of the axones is still uncertain, whether dependent entirely on the cell-body or partly independent; the unsheathed axone is bathed by lymph. The neurone is evidently a unit, since severing an axone leads to degeneration, not only in the axone but to a certain extent in the cell-body. The latter, however, may be due to the loss of its usual channel for activity. Regeneration is possible if the connection between the axone and the cell-body can be reëstablished. Up to a certain point in individual development, new nerve-cells are formed by division. Whether this is possible in the adult brain, new nerve-cells being formed to take the place of those which have been injured, is still uncertain, with the evidence pointing toward a negative.

Our knowledge as to the functions of different parts of the neurone is incomplete. In some cases, though not in all, the dendrites, through their branches, receive a stimulus which, traversing the cell-body, is passed out through the ends of the axone. Probably nerve-impulses may pass in both directions, since the neurone as a whole is a conductor. The nerve-cell simply represents a specialization of the conductivity of the original one-celled organism. Its function is to conduct stimuli.

Just how this conduction takes place we do not know. A slight stimulus from the outside world often sets free a series of movements involving a very much larger amount of energy. This increase of energy is supplied by the organism itself. Conduction must be to some extent connected with the instability of the chemical compounds of the neurone, and the process of metabolism constantly going on. The region of the brain is especially well supplied with blood, and the pressure rises almost at once when intellectual activity begins. There is also a slight rise of temperature, indicating more active metabolism. In any neurone bad nutrition means poor conduction. Over-stimulation leads to fatigue—that is, the exhaustion of food (energy) reserves. Under-stimulation seems to lead to degeneration. On the other hand, there is considerable recent evidence to show that the conduction itself is a physical rather than a chemical process.

The rate of conduction, as studied by electrical stimulation of a frog's nerve, is about 3×10^3 centimeters per second. (It is interesting to compare this with the velocity of the electric current along a perfect conductor, which is 3×10^{10} cm. sec.) In practice, the rate of conduction is very much lower, since we have to deal not with individual nerve-cells but with nerve-cells organized into a nervous system.

Neurones form part of what may be termed reflex arcs, each consisting of a receptor, a chain of conducting cells, and an effector. What is ordinarily measured, therefore, is a reflex, or round-trip reaction. The flexion reflex in a dog's hind leg would have an arc of about two-thirds of a meter, and would require .027 seconds at the rate of conduction for a single neurone. Sherrington finds this rate reached or exceeded only with a very strong stimulus. Double that period is common, and with a mild stimulus it may reach as high as two-tenths of a second. He considers the delay to be due chiefly to the "synapse," or surface of separation between individual neurones.* One peculiarity of the reflex-arc is that the stimulus always passes in the same direction.

Let us take up the reflex-arc in more detail. The receptor is a cell especially adapted to receive stimuli. Most of these are on the outer surface of the animal, which is in direct contact with the environment. Embedded in the dermis are certain cells, some of which are sensitive to touch, others to temperature, etc. Still other receptors, probably naked nerve-endings, respond to any stimulus which tends to do harm to the skin. The sense organs are organized groups of receptor-cells, enabling an animal to respond to environmental stimuli coming to it from a distance. Receptors are found also to a certain extent on the internal surface of the animal, which is in contact with food and other material derived from the environment. Once more, receptor-cells are found in connection with the muscles, organs, blood-vessels, etc. These cells are affected only indirectly by the environment, but are sensitive to changes going on within the organism.

* Charles S. Sherrington, *Integrative Action of the Nervous System,* 1906, p. 19, *et passim.*

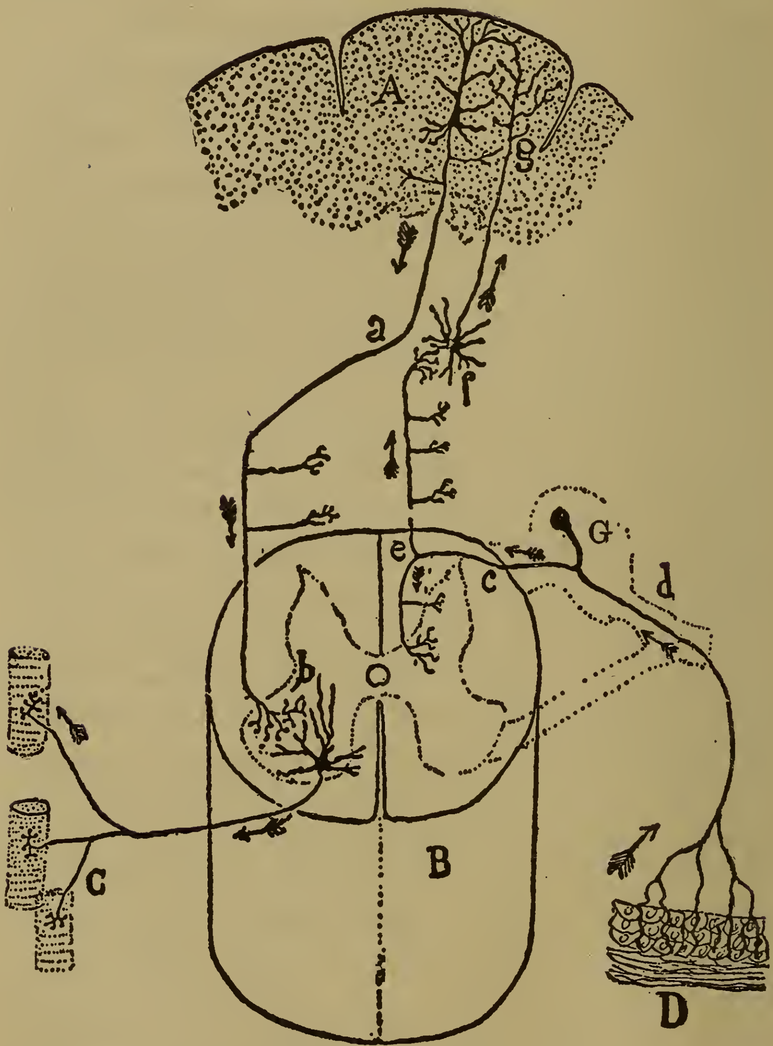


DIAGRAM ILLUSTRATING NEURONE SERIES*

*From *The Nervous System.* G. E. Stechert & Co., New York (1909).

We pass next to the chain of ingoing nerve-tracts. What may be called the sensory neurones of the first series are all found outside the spinal cord, from which they have wandered. Each of these nerve-cells puts out two axones. One goes toward the periphery to innervate, through its branches, a number of receptor-cells. It ordinarily conducts the particular stimuli to which these receptors are sensitive, and no others, although it is capable of conducting the electrical stimuli of the laboratory, if these are of sufficient strength. The other axone goes to the spinal cord, enters it and divides, one branch passing down, one passing up for a considerable distance, perhaps as far as the cerebellum. In all cases, even for the hands and feet, the sense impression is carried well within the central nervous system by means of a single cell.

The sensory nerves of the second series are not as well known. They start at various levels of the spinal cord and in the lower regions of the brain. Through their dendrites and cell-bodies they collect impressions from the axone-ends of the first neurones. The path followed is extremely varied, as is the length of the

---

Diagram Illustrating Neurone Series

Scheme of peripheral spinal sensory neurone showing the peripheral process, *d,* extending to the sensory surface *D,* and a central axone *c,* entering the spinal cord through the dorsal root of a spinal nerve, there bifurcating at *e* into an ascending and a descending limb which give off numerous collaterals. The cell body is shown in the spinal ganglion *G. A* is motor neurone in cortex, *b* a segment of spinal cord, *c* motor neurone connecting with muscles. (After S. Ramón y Cajal, Les nouvelles idées, etc. Translated by Asoulay, Paris, 1894, p. 25, Fig. 6.)

axones. In some cases these neurones of the second series carry the conduction as far as the cortex. The majority probably end in the optic thalami at the base of the hemispheres. Thence the stimulus is transmitted to the cortex by from one to eight additional series of neurones. (The most roundabout conduction paths are those by way of the cerebellum.) Each neurone, through its dendrites, is in constant communication with a vast number of other neurones, both sensory and motor, in the same general level. The net result must be a pretty constant activity on the part of all the nerve-cells.

Turning to the outgoing nerve-tracts, or motor-neurones, governing the muscles of various parts of the body, the nerve-cells of the first series (to reverse the order) have their cell-bodies located in the cortex, from which axones descend to varying levels: some few as far as the lower end of the spinal cord, in other cases only to lower sections of the hemispheres or to the other regions of the brain. Thence the stimulus is carried to the neurones of the end-series by from one to a number of connecting series, as in the case of the sensory nerves. The cell-bodies and dendrites of the lower motor-neurones are all within the central nervous system, usually in the medulla or the cord, where they form distinct columns of gray matter. Their axones, passing out of the cord at the joints of the segments, have followed the ancestral muscle-cells in their wanderings, so that the easiest way to locate the original segmentation of a muscle is to trace the nerves by which it is governed. Each axone-end of a motor-neurone is usually in contact with, or actually buried in, a muscle-cell.

In the upper brain, besides the sensory and motor neurones or their parts, already described, we find other neurones which simply connect different regions. Some of these connect the two hemispheres (the cell-body being located in one and its axones reaching the cortex of the other). The others, known as association neurons, are found in a single hemisphere. The cell-bodies are located in the cortex, or gray rind of the brain, with short or long axones; in the latter case they have often been traced to widely separated regions.

Having described the parts of a reflex-arc, we are now prepared to see it in action. Let us take as an example the scratch-reflex of a dog's left hind foot, as studied in a "spinal" dog—that is, one deprived of its brain. A mechanical stimulus on the shoulder is carried by one or more neurones from the skin to the gray matter of the corresponding segment of the spine. In this case, if several scratch-receptors are stimulated simultaneously they reinforce one another. The conduction is not continuous but rhythmic, the neurones exhibiting a "refractory phase." A second neurone acts as a common path for these irritation-stimuli, and for no others, carrying the summated stimulus from the shoulder segment to the leg segment of the cord. Thence the stimulus is carried to the muscle by a third (motor) neurone, which acts as a final common path

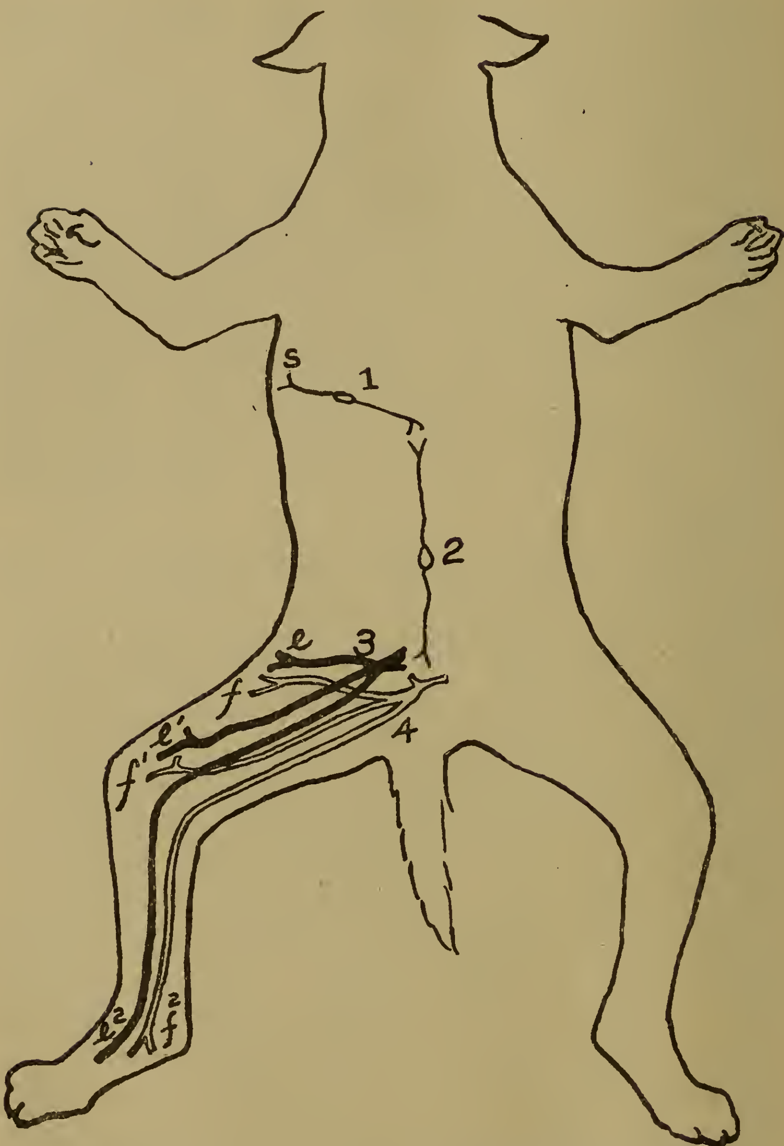


DIAGRAM ILLUSTRATING SCRATCH-REFLEX IN DOG for many sorts of stimuli from various parts of the body. (Only one impulse may be carried at a time, the different sorts of stimuli mutually interfering; each has its characteristic quality, which modifies the resulting reflex.) In the case of the scratch-reflex, the third link evidently consists of two neurones (or sets of neurones), one reaching the extensor muscles of hip, knee and ankle, the other reaching the corresponding flexor muscles. The refractory phase in these cases takes the form of alternate contraction and inhibition. The result is a rhythmic alternation of flexion and extension, each recurring about four times per second, the net result being a rapid scratching of the irritated part. Even such a simple reflex as this is an elaborate mechanical process, involving the spacial and temporal coördination of a number of distinct neurones. This coördination is as much a matter of inheritance as is the arrangement of skin, nerves and muscles. By analogy we may suppose it to originate in the mutations of the dog's zoölogical history. The human animal exhibits many reflexes of this automatic type.

Passing to the field of reflex action which involves the higher centers, the following points may be noted.

Diagram Illustrating Scratch-Reflex in Dog

s, scratch receptor on surface of shoulder.
e, *e*,[1] *e*,[2] nerve endings in extensor muscles of hip, knee and ankle.
f, *f*,[1] *f*,[2] same in flexor muscles of hip, knee and ankle.
1, neurone conducting stimulus from receptor.
2, neurone in spinal cord acting as common path.
3, final common path to extensor muscles.
4, final common path to flexor muscles.

The vast number of reflex-arcs in the normal animal are coördinated as a single nervous system. "The singleness of action from moment to moment thus assured," says Sherrington, "is a keystone in the construction of the individual whose unity it is the specific office of the nervous system to perfect. . . . It is not usual for the organism to be exposed to the action of only one stimulus at a time. It is more usual for the organism to be acted on by many stimuli concurrently, and to be driven reflexly by some group of stimuli which is at any particular moment prepotent in action on it. Such a group often consists of some one pre-eminent stimulus with others of harmonious relation reinforcing it, forming with it a constellation of stimuli, that, in succession of time, will give way to another constellation which will in its turn become prepotent."*

All the important reflex-arcs have circuits leading through the cortex of the cerebrum, and the reflex may be started or inhibited in the cortex. As to the nature of the physiological dominance of the brain, I may quote some further passages from Professor Sherrington. "In motile animals constituted of segments ranged along a single axis, *e.g.*, vertebrata, when locomotion of the animal goes on, it proceeds for the most part along a line continuous with the long axis of the animal itself, and more frequently in one direction of that line than in the other. The animal's locomotor appendages and their musculature are favorably adapted

* *Integrative Action of the Nervous System,* 176.

for locomotion in that habitual direction. In the animal's progression certain of its segments therefore *lead*. The receptors of these leading segments predominate in the motor taxis of the animal. They are specially developed. Thus, in the earthworm, while all parts of the external surface are responsive to light, the directive influence of light is greatest at the anterior end of the animal. The leading segments are exposed to external influences more than are the rest. Not only do they receive *more* stimuli, meet *more* "objects" demanding pursuit or avoidance, but it is they which usually *first* encounter the agents beneficial or hurtful of the environment as related to the individual. Pre-eminent advantage accrues if the receptors of these leading segments react sensitively and differentially to the agencies of the environment. And it is in these leading segments that remarkable developments of the receptors, especially those of the extero-ceptive field, arise. Some of them are specialized in such degree as almost obscures their fundamental affinity to others distributed in other segments. Thus among the system of receptors for which radiation is the adequate agent there are developed in one of the leading segments a certain group, the *retinal,* particularly and solely, and extraordinarily highly, amenable to radiations of a certain limited range of wave-length. These are the *photo-receptors,* for which light and only light, *e.g.* not heat, is the adequate stimulus. In like manner a certain group belonging to the system receptive of mechanical impacts attains such susceptibility for these as to react to the vibrations of water and air that constitute physical sounds. The retina is thus a group of glorified 'warm-spots,' the cochlea a group of glorified 'touch-spots.' Again, a group belonging to the system adapted to chemical stimuli reach in one of the leading segments such a pitch of delicacy that particles in quantity unweighable by the chemist, emanating from substances called odorous, excite reaction from them."

"It is in the leading segments that we find the *'distance-receptors.'* For so may be called the receptors which react to *objects* at a distance. These are the same receptors which, acting as sense-organs, initiate sensations having the psychical quality termed *projicience.* The receptor organs adapted to odors, light, and sound, though stimulated by the external matter in direct contact with them, as the vibrating ether, the vibrating water or air, or odorous particles,—yet generate reactions which show 'adaptation,' *e.g.,* in direction of movements, etc., to the environmental *objects* at a distance, the *sources* of those changes impinging on and acting as stimuli at the organism's surface."

"The 'distance-receptors' seem to have peculiar importance for the construction and evolution of the nervous system. In the higher grades of the animal scale one part of the nervous system has, as Gaskell insists, evolved with singular constancy a dominant importance to the individual. That is the part which is called the brain. *The brain is always the part of the nervous system which is constructed upon and evolved upon the 'distance-receptor' organs.* Their effector reactions and sensations are evidently of paramount importance in the functioning of the nervous system and of the individual."

"As initiators of reflex movements the action of the distance-receptors is characterized by tendency to work or control the musculature of the animal as a *whole*,—as a single machine,—to impel locomotion or to cut it short by the assumption of some *total* posture, some attitude which involves steady posture not of one limb or one appendage alone, but of all, so as to maintain an attitude of the body as a whole. Take, for instance, the flight of a moth toward a candle, the dash of a pike toward a minnow, and the tense steadiness of a frog about to seize an insect. These reactions are all of them excited by distance-receptors, though in the one case the musculature is impelled to locomotion toward the stimulus (positive phototropism), in the other restrained (inhibited) from locomotion. . . . In both reactions the skeletal musculature is treated practically as a *whole* and in a manner suitably anticipatory of a later event. . . . The projicient receptors and their reflexes once gone, even intense stimuli do not *readily* move or arrest the creature as a whole. It is relatively difficult to get the 'spinal' frog to spring or swim."

"The series of actions of which the distance-receptors initiate the earlier steps form series much longer than those initiated by the non-projicient. Their stages, moreover, continue to be guided by the projicient organs for a longer period between initiation and consummation. Thus in a positive phototropic reaction the eye continues to be the starting place of the excitation, and in many cases guides change in the direction not only of the eyeball but of the whole animal in locomotion as the reflex proceeds. The mere length of their series of steps and the vicissitudes of relation between bodies in motion reacting on one another at a distance conspire to give to these precurrent reflexes a multiformity and complexity unparalleled by the reflexes from the non-projicient receptors. The reaction started by 'distance-receptors' where positive not only leads up to the consummatory reactions of the non-projicient, but on the way thither associates with it stimulation of other projicient receptors, as when, for instance, a phototropic reaction on the part of a Selachian brings the olfactory organs into range of an odorous prey, or, conversely, when the beagle sees the hare after running it by scent. In such a case the visual and olfactory receptor arcs would be related as 'allied' arcs, and reinforce each other in regard to the mesencephalo-spinal path, or in higher mammals the 'pyramidal' or other pallio-spinal path. It is easy to see what copious opportunity for adjustment and side connection such a reaction demands, consisting as it does of a number of events in serial chain, each link a modification of its predecessor."*

In the higher vertebrates (below man) even the coördination of these cerebral reflex-arcs is chiefly a matter of inheritance. We have seen that in human coördination education plays a very much larger part.

* *Op. cit.*, 223 *ff.*

The child must learn space by innumerable reactions.

It seems probable that man inherits a full set of neurones. The deaf-mute idiot often has as large and complex a brain as a child whose distance-receptors have been intact. Physiology has made little progress in determining just what is involved in the training of the cortical neurones for use in controlling the lower motor centers. About the only clue so far is that furnished by the studies of Flechsig in the successive sheathing of neurones with myellin or white matter. For example, in the unmapped area of the human brain, in which are found the centers directly involved in speech and thought, the axones acquire their sheaths at a somewhat later period than the axones in the sensory and motor areas. Is this acquirement due to inheritance, or is it due to the use of these axones by the individual? In the development of the individual brain, do the neurones of the cortex send out new or longer axones to form new connections (associations) as they are needed? Or is the undoubted plasticity of even the adult brain to be explained by the passage of stimuli across synapses and along neurone-chains already in place but never before utilized?

The nerve-cells of the cortex do not appear to differ from other neurones, unless it is in their greater chemical instability. Like other neurones they undergo certain energy-transformations and thus conduct stimuli. On account of the enormous number of nerve-cells in the cortex and their connections with each other through axones and dendrites, it is probable that energy-transformation and conduction is almost continuous, in both hemispheres. That is about as far as brain physiology carries us, or perhaps is likely to carry us. There is nothing in the individual brain-cells or in the machinery of reflex-arcs, wonderful as this is, to suggest the higher mental processes. To these we must now turn our attention.

CHAPTER XIII

THE HUMAN MIND

WHAT is consciousness? I shall begin with the statement of a distinguished physiologist: "The fundamental process which recurs in all psychic phenomena is the activity of the associative memory, or of association. Consciousness is only a metaphysical term for phenomena which are determined by associative memory. By associative memory I mean that mechanism by which a stimulus brings about not only the effects which its nature and the specific structure of the irritable organ call for, but by which it brings about also the effects of other stimuli which formerly acted upon the organism almost or quite simultaneously with the stimulus in question. If an animal can be trained, if it can learn, it possesses associative memory. By means of this criterion it can be shown that Infusoria, Coelenterates, and worms do not possess a trace of associative memory. Among certain classes of insects (for instance, wasps), the existence of associative memory can be proved. . . . Only certain species of animals possess associative memory and have consciousness, and it appears in them only after they have reached a certain stage in their ontogenetic development. This is apparent from the fact that associative memory depends upon mechanical arrangements which are present only in certain animals, and present in these only after a certain development has been reached."*

Physiologically and historically this statement is undoubtedly correct. Among plants and the lower animal organisms the only "psychic" life is that which I have already described under the categories of biology. It is quite evident that there is no break in evolution when consciousness appears in the species, no break in development when it arises in the individual. Psychic phenomena are merely a higher order of biological phenomena. In the more developed animals the irritability of the original single cell has become specialized in distinct nerve-cells. These have increased in man to three billion. The fused and coöperative life of these three billion cells, or their principal representatives, constitutes what we know as mind.

We have still to answer the question: "What is consciousness?" For a description, one may study his own mental states, or compare notes with others who are making the same study. But this does not carry us very far. The weakness of the old introspective psychology has been its inability to apply experimental methods. Until we can experiment on an object, we have no sure antitoxin for illusion. Experimental psychology is, for the most part, not psychology at all, but physiology. The lack is now beginning to be supplied by the systematic study of human behavior.

In the first place, what is the normal human mind able to do? What activities are open to the cells of the

* Loeb, *Comparative Physiology*, 12.

cortex in the left hemisphere, acting more or less as a unity? I attempt an answer in the following summary, which includes a number of points already touched on. Some abnormal cases will be discussed in the next chapter.

In the stream of human mental life there appear a succession of sensations, arising in most cases as stimuli from organic processes or from the external world, these stimuli being transmitted by the body or its sense organs through the proper neurone chain. These may be followed by revivals of past sensations. The stream may become the perception of an object. It may become a recept or a still more abstract concept, symbolized by a thought word. Through the parts of the brain controlling audible speech and the muscles of vocalization, the word may actually be spoken. Every normal human adult, whether savage or civilized, is able to speak. And, where other humans attach similar meanings to the symbolic sounds used, he is able to talk. Our elaborate languages, originating long before the invention of writing, are one of the greatest monuments to the power of the human mind.

Speech involves memory. Every normal man can remember, to a degree unknown among the other animals. As to the mechanism of memory—how mental states are registered in the brain-cells and afterwards revived—we are almost completely in the dark. It seems probable that the process is similar to that involved in habit: by frequent repetition certain associations of sensory and motor neurones come to be more or less permanent, so that a stimulus, once started, will follow that line and no other. Man is able to revive sensations, percepts, thought-concepts, spoken word-concepts, written word-concepts. Each department of conceptual life has a more or less definite center in the brain, injury to which involves a loss of memory in that department.

Man is conscious in the fullest sense. He not only perceives objects, but he knows that he perceives them. He can make an object of his own mental processes. He is able to distinguish himself from other men, or from objects in the external world. He can even distinguish himself from parts of his own body. Professor James has taught us to notice a number of different elements in a man's self: the material self, the body, clothes, family, home, property; the social self, the recognition he receives from his fellows, his place in the community life; the spiritual self, his memories, opinions, preferences, ambitions—among these "selves" there is a certain interaction and rivalry—and lastly the pure ego, or whatever is involved in the sense of personal identity and the appropriation of past experiences as belonging to the "me."* Each of these "selves" is of importance in the social history of the race.

The stream of mental life may take other directions. Man is not only able to form images of the objective world and of his own states, but he is able, by means of

* William James, *Principles of Psychology,* 1890, vol. I, chap. X.

revived images, to imagine ideal objects, associations and states. He thus lives in the future as well as in the past and present. Imagination is of great importance, even in savage life, as intensifying or supplementing primitive instincts or emotions, such as fear, love, hate, the desire for food, shelter or ornament, etc. It is the basis of pictorial art, and of literature, from the first story-telling to the classics of civilized man. It is one of the principal sources of invention, of improvement in the arts, of the discovery of new regions, new business openings, new facts, new hypotheses.

All the higher animals are capable of emotion. But in the case of man this is not confined to instinctive reactions. An object that is merely imagined may excite as strong feeling as an external object. It seems probable that all emotion has a certain basis in bodily sensations. But man is generally able to neglect these bodily sensations and so control his emotions, a power that is technically known as inhibition. Emotions play a great part in the sexual life of man, in his social life, in art, music and literature. They are the foundation of those judgments of value by which his practical choices are largely governed.

The stream of consciousness may take the form of reasoning. Various concepts are revived in new groupings.. The new concept which results is largely an abstraction of what is like or unlike in the revived concepts. Thus a savage comes on a mound of earth that resembles a snake. This sets him to thinking of the snake as a dangerous being he would like to be able to control. It occurs to him that by operating on the image of the snake he will be able to control the snake (what is known as sympathetic magic). Again, the physician comes on a case of paralysis of the right side of the body. He finds that the left cerebral hemisphere has been injured. He draws the conclusion that the left hemisphere controls the right side of the body. Reasoning, like conception, is exclusively a human power. To this power is chiefly due man's dominant place in nature. It enables him to interpret and profit by experience. It opens to his knowledge the world in which he lives. It makes possible such achievements as the *Kritic of Pure Reason* or the synthetic philosophy or the Zambesi bridge or the discovery of radium or the doctrine of relativity.

Finally, man's mental stream may consist of volitional control. This may appear as attention to certain sensations, emotions or revived images. It may take the form of control over lower regions of the central nervous system. Such control is limited both in scope and in degree, but by no means as limited as in other animals. Man, for instance, is able for an appreciable moment to stop breathing, a nervous-muscular process that usually goes on mechanically. He has almost complete control over vocalization and the focussing of his organs of sight. The most important exercise of this power is in the control of his limbs. Adult man can employ his hands in hunting, house-building, the making and use of tools, writing, drawing, piano-playing, the operation of elaborate machines. For this purpose, as already stated, certain regions of the left hemisphere are specially educated. In all these cases of volition man apparently is able to choose between ideas, different courses of action, different uses to which he shall put his fingers. Which he will choose of two alternatives presenting themselves in the stream of consciousness may depend on emotion or reason or mental habit. But the choice itself consists of attending, with more or less feeling of effort, to the one and dismissing the other.*

Is human behavior so consistent that it may be predicted with accuracy? Undoubtedly, as far as relates to the response of the normal waking organism to its environment. Laws governing such response may be formulated. In the present state of our knowledge, it is doubtful whether the same laws can be applied without modification to the thought life of man, to sleep and allied states, or to the abnormal. With these reservations I give Thorndike's scheme, based on comparative psychology and physiology.

1. "The same situation will, in the same animal, produce the same response; and if the same situation produces on two occasions two different responses, the animal must have changed. . . . The changes in an organism which make it respond differently on different occasions to the same situation range from temporary to permanent changes. Hunger, fatigue, sleep, and certain diseases on the one hand, and learning, immu-

* So James, *op. cit.,* II, 570.

nity, growth and senility on the other, illustrate this range."

2. The law of original behavior, or instinct. "To any situation an animal will, apart from learning, respond by virtue of the inherited nature of its reception-, connection-, and action-systems."

3. The law of effect. "Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened, so that, when it recurs, they will be less likely to occur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond."

4. The law of exercise. "Any response to a situation will, other things being equal, be more strongly connected with the situation in proportion to the number of times it has been connected with that situation and to the average vigor and duration of the connections."*

It is possible to go further and formulate the social law that two or more men, with the same general education, are likely to respond in the same way to similar situations. This explains the parallelisms of thought and action so frequently met with in human history, es-

* *Animal Intelligence,* 241 *ff.*

pecially among primitive races. All these laws illustrate the fact, to which I have earlier alluded, that the development of the human mind is a process of adjustment to the physical world in which we find ourselves. Man responds consistently to the sensations of sight, touch, etc., which reach him from his environment, because it is by those very sensations that his brain and mind have been educated.

In the biological section of our work, we raised the question: "What is life?" and attempted to give a provisional answer. What further light has been thrown on this question in the portion of the psychological field which we have just traversed? Psychology, strictly speaking, is only a subdivision of biology. That which we call "mind" is a certain phase of the life of a higher organism taken as a whole. It represents the specialization and perfection of that side of organic life which we described under our first biological category—active adjustment to environment. Whatever comes under that category, from the irritability of the simplest protozoan to the bridge-building or legislation or philosophizing of the human species, may properly be termed psychical. What do these psychical facts teach us as to life in particular and the universe in general?

Mind as we are able to observe it is, to use a chemical expression, always in combination and never free. We have no knowledge of mind apart from a brain and nervous system; it is always organized, like life itself. Constant reference has been made to this constant parallelism between nerve-cells on the one side and the stream of consciousness on the other. Psychology simply assumes the fact of parallelism. The first question before us, as philosophers, is whether brain or mind is fundamental. Are the familiar mental phenomena produced by the physical processes of body and nerve-cells, or does the psychical itself organize and control these cells?*

Many considerations point toward the latter as the true answer: the mind organizes the brain. There is, first of all, the evidence of biology. We were led to define life provisionally as that which is able to organize inorganic material into a cell-machine, and, through a number of such organic machines, of constantly increasing complexity, to exercise further control over physical energies and forces. There is nothing in inorganic, physical processes to suggest this active adjustment, this organizing and control which are characteristic of all biological and so of all psychical phenomena.

Again, there is nothing in the known activity of the nerve-cells to represent consciousness. The physical changes which take place in neurones when transmitting stimuli are one thing, the accompanying sensations, percepts and concepts are quite another thing. This fact is one of the commonplaces of psychology.

The gradual evolution of species at least suggests that mind is the organizing and controlling factor.

* There is no real evidence for a third alternative—that mind and brain are forever parallel and that neither acts upon the other.

Organisms must adjust themselves to the world in which they live. The machinery for such adjustment grows ever more complex and complete. Certain cells are set apart to serve this particular function. A central nervous system evolves, with ingoing and outgoing nerve-tracts. Part of this central nervous system becomes a brain. The upper regions of the brain are specialized and assume a certain control over the lower. And, as a consequence, the life or mind in man is able to do all that we have described. He can do it because he has the machinery to use for such a purpose. Let there be a break in the machinery he has been accustomed to use, and the mind of man becomes correspondingly incapacitated.

This argument is suggestive, but not by any means conclusive. The process may legitimately be given the reverse interpretation, and our mental states resolved, as with Huxley, into " the symbols in consciousness of the changes that take place automatically in the organism." But one series of facts adds impressive weight to the idea of the brain as simply the organ utilized by the mind in its varied activities. These facts have been developed in the little book on "Brain and Personality." Dr. Thomson's analogies are often misleading and his conclusions unwarranted, but the facts he gives are essentially sound. Physiologically the two halves of the brain tend to correspond, even to minute details. There is no inherent reason why both should not develop as the organs for speech and the higher mental processes, or why one hemisphere should develop rather than the other. The explanation is, in one sense, purely mechanical. It depends on early right- or left-handedness, which, as far as our present knowledge goes, is an arbitrary and accidental matter.

The association of one or the other hand with further brain development is undoubtedly due to the association of gesture and vocalization in the early attempts at expression. Gesture language is the first language used by children, and it plays a large part in the life even of civilized adults. Dr. Thomson calls attention to the close proximity, in the motor regions of the brain, of the area governing the movements of the hand and the "centers which preside over the movements of the muscles of the face, of the lips and of the tongue. A common and associated action of these parts, therefore, would be much more natural than between the muscles of the face, for example, and those of the leg. We can then see how readily facial expression, lending itself to gesture in attempts at communication, would seek the coöperation of lip and tongue for vocal sounds. . . . But as the right hand is the oftenest used for every purpose, so is it of the two hands the oftenest used for gesture, which means of course for language. As soon as other parts were sought for to coöperate with gesture in language, the appeal would necessarily be to the neighboring centers in the left brain, and not by crossing the corpus callosum bridge to the corresponding centers in the other hemisphere. It would not be long, therefore, before the habit became settled to use only parts in the left brain for this specialized work, until finally the habit became fixed for life."*

All other training of the nervous system and brain, even the development of special centers for word-seeing and word-hearing, is carried on by the environment, acting through the sensory series of nerves, with their mechanical transmission of stimuli. Because of the unvarying character of these stimuli, a nerve center becomes accustomed to transmit them to the same set of motor nerves. Of such acquired habits the outside world is the ultimate source. But in the case of speech and thought the training is done, not through the sensory but through the motor nerves.† It is these which are involved in gesture and vocalization. Speech and gesture, it is true, may be called out by the environment. But the response is active, not merely passive. The mind of the child, or some section of the mental life associated with the cerebral cortex, regulates the response which is given. Indirectly, this regulative agent, whatever it is, fashions the brain, by organizing centers to perform new functions, and by projecting (or training) new association fibers.

In other words, whenever a child learns to talk and has certain centers in one of its cerebral hemispheres educated for that purpose, we have a concrete instance of mind—whatever that may be—controlling brain. "We can make our own brains," as Dr. Thomson says,

* Wm. H. Thomson, *Brain and Personality,* 1908, p. 114 *ff.*

† The same thing is illustrated in the Montessori system of education, where the child learns to write through tracing sandpaper letters with the fingers.

"so far as mental functions or aptitudes are concerned, if only we have wills strong enough to take the trouble. . . . While it is doubtless true that all individuals of our race are not born with equally good brains, yet the fact remains that the special mental capacities for which certain men have become eminent were all acquired and were not congenital. . . . In other words, a great personality may possibly make a good brain, but no brain can make a great personality."*

"The reaction of reflex arcs," says Sherrington, "is controllable by the mechanism to whose activity consciousness is adjunct. The reflexes controlled are often reactions but slightly affecting consciousness, but consciousness is very distinctly operative with the centers which exert the control. It may be that the primary aim, object and purpose of consciousness is control. 'Consciousness in a mere automaton,' writes Professor Lloyd Morgan, 'is a useless and unnecessary epiphenomenon.' As to *how* this conscious control is operative on reflexes, how it intrudes its influence on the running of the reflex machinery, little is known."†

The control of the physical by the mental is even more apparent in the subconscious, a field that will occupy our attention in the next chapter. An idea impressed on the hypnotic subject will start or inhibit almost any reflex or group of reflexes. He will feel pain when there is no wound, and feel nothing when the wound is severe. He will be mentally blind to

* *Id.*, 223, 233, 234.
† *Enc. Brit.*, IV, 405 a.

objects in the same room, or discern objects beyond the range of normal vision. The subconscious mind is able to regulate to a minute detail the circulation of the blood, causing scars or hemorrhages to arise in a certain spot merely through suggestion. Suggestion will cause a patient to sweat at a fixed hour, it will lower the temperature of the hand ten degrees, it will cure eczema, neuralgia and other bodily diseases.

The induction which we made in regard to life seems thus far to be confirmed by the study of mind. There is nothing in the psychical field, sub-human or human, that is inconsistent with the idea of vital control, and there is much that confirms it. We may define mind provisionally as that form of life which, through the machinery of nerve-cells, synapses and reflex-arcs, is able to direct and control the muscle-cells in the same organism, and, indirectly, the energies and forces of the external world.

CHAPTER XIV

THE SUBCONSCIOUS

DURING the last thirty years or more, another continent has been added to the known world of psychology. The scientific development of abnormal or unusual mental states has thrown a new light on the problem of personality, very much as the study of diseased tissue has been teaching medical men the nature of tissue. Consciousness is now, as it were, on an experimental basis. I outline here some of the most important material thus far gathered, leaving its interpretation for a following chapter.

(a) Certain groups of phenomena which may be covered by the somewhat frayed term *intuition.* While the normal mind reaches its conclusions by a process of induction, whether crude or scientific, there are cases where a conclusion or judgment is reached, or appears to be reached, directly, without the use of the elaborate machinery of associations established in the brain.

We have first the case of persons in extreme danger. Many of the ordinary physical processes are weakened or inhibited, but the mind acts with unusual clearness, deciding without hesitation on a proper and often new course of action. At times the body is made to perform feats of agility, strength or endurance impossible under ordinary circumstances.

We have next the intuition of the prodigy, especially in mathematics. In most of the lightning calculators known to us, the gift appeared at an age of from three to ten, and lasted only a few years. In this it resembles the visualizing power, which is stronger in childhood than in adult years. Remarkable mathematical aptitude may appear in stupid people, as well as in those normally intelligent. Dr. Whately writes of his own case: "There was certainly something peculiar in my calculating faculty. It began to show itself at between five and six, and lasted about three years . . . I soon got to do the most difficult sums, always in my head, for I knew nothing of figures beyond numeration. I did these sums much quicker than any one could upon paper, and I never remember committing the smallest error. When I went to school, at which time the passion wore off, I was a perfect dunce at ciphering, and have continued so ever since." "Buxton would talk freely whilst doing his questions, that being no molestation or hindrance to him." Edward Blyth, who retained his gift in later life, says: "I am conscious of an intuitive recognition of the relation of figures. For instance, in reading statements of figures in newspapers, which are very often egregiously wrong, it seems to come to me intuitively that something is wrong, and when that occurs I am usually right. I have always felt that there were times when my power was much weaker than others, not only when tired, but, like a musician, when not in the mood. I have not the same confidence now at 66 years of age as when younger. That is to say, I like to check a calculation before stating it, though I can do nearly as difficult ones as at any time of my life, though not so rapidly." "Whenever," Bidder says, "I feel called upon to make use of the stores of my mind, they seem to rise with the rapidity of lightning."*

Hudson has cited the case of the musical prodigy known as "Blind Tom," a negro. "This person was not only blind from birth, but was little above the brute creation in point of objective intelligence or capacity to receive objective instruction. Yet his musical capacity was prodigious. Almost in his infancy it was discovered that he could reproduce on the piano any piece of music that he had ever heard. A piece of music, however long or difficult, once heard, seemed to be fixed indelibly in his memory, and usually could be reproduced with a surprising degree of accuracy. His capacity for improvisation was equally great, and a discordant note rarely, if ever, marred the harmony of his measures."†

Akin to the intuition of the prodigy is that commonly met with in genius, and less frequently in the mental life of the average man. Conclusions are reached, judgments formed, problems solved, without conscious effort, without any apparent association with the mental stream flowing at the time. Many of our scientific discoveries and hypotheses have come in this way.

* F. W. H. Myers, *Human Personality and its Survival of Bodily Death,* 1903, Vol. I, 79 *ff,* based largely on art. by Scripture in *Am. J. of Psychology,* Vol. IV, No. 1.

† T. J. Hudson, *Law of Psychic Phenomena,* 1893, p. 68.

Sometimes the thinker was in a state of revery, sometimes actively engaged and thinking of something else. "One does not work," writes de Musset, "one listens; it is like a stranger who talks to you at your ear." Lamartine says: "It is not I who think; it is my ideas which think for me." "My conceptions," says another, "rise into the field of consciousness like a flash of lightning or like the flight of a bird." "In writing these dramas I seemed to be a spectator at the play; I gazed at what was passing on the scene in an eager, wondering expectation of what was to follow. And yet I felt that all this came from the depth of my own being." Ideas may need time to mature. M. Sully Prudhomme writes: "I have sometimes suddenly understood a geometrical demonstration made to me a year previously without having in any way directed thereto my attention or will. It seemed that the mere spontaneous ripening of the conceptions which the lectures had implanted in my brain had brought about within me this novel grasp of the proof." Dr. Arago: "Instead of obstinately endeavoring to understand a proposition at once, I would admit its truth provisionally;—and next day I would be astonished at understanding thoroughly that which seemed all dark before."*

Combe, a French artist, who was able to paint in one year over three hundred portraits of unusual fidelity, thus described his method: "When a sitter came, I looked attentively on him for half an hour, sketching

* Chebaneix, *Le Subconscient chez les Artistes, les Savants, et les Ecrivains,* Paris, 1897. Quoted by Myers, *op. cit.,* I, 89.

from time to time on the canvas. I did not require a longer sitting. I removed the canvas and passed to another person. When I wished to continue the first portrait, I recalled the man to my mind. I placed him on the chair, where I perceived him as distinctly as though really there, and, I may add, in form and color more decidedly brilliant. [This, as we shall see, is a characteristic of waking hallucinations.] I looked from time to time at the imaginary figure, and went on painting, occasionally stopping to examine the picture exactly as though the original were there before me; whenever I looked toward the chair, I saw the man."*

We may hear next from M. de Curel, a French dramatist. "He begins in an ordinary way, or with even more than the usual degree of difficulty and distress in getting into his subject. Then gradually he begins to feel the creation of a number of quasi-personalities within him;—the characters of his play, who *speak* to him;—exactly as Dickens used to describe Mrs. Gamp as speaking to him in church. These personages are not clearly visible, but they seem to move round him in a scene—say a house and garden—which he also dimly perceives, somewhat as we perceive the scene of a dream. He now no longer has the feeling of composition, of creation, but merely of literary revision; the personages speak and act for themselves, and even if he is interrupted while writing, or when he is asleep at night, the play continues to compose itself in his head. Sometimes while out shooting, etc., and not thinking

* *Law of Psychic Phenomena,* 58.

of the play, he hears sentences rising within him which belong to a part of this play which he has not yet reached."*

In another field we have the case of Henry Clay, unexpectedly called upon to answer an opponent on a question in which he was deeply interested. Clay felt too unwell to reply at length. "It seemed imperative, however, that he should say something, and he exacted a promise from a friend, who sat behind him, that he would stop him at the end of ten minutes. Accordingly, at the expiration of the prescribed time the friend gently pulled the skirts of Mr. Clay's coat. No attention was paid to the hint, and after a brief time it was repated a little more emphatically. Still Clay paid no attention, and it was again repeated. Then a pin was brought into requisition; but Clay was by that time thoroughly aroused, and was pouring forth a torrent of eloquence. The pin was inserted deeper and deeper into the orator's leg without eliciting any response, until his friend gave it up in despair. Finally Mr. Clay happened to glance at the clock, and saw that he had been speaking two hours; whereupon he fell back into his friend's arms, completely overcome by exhaustion, upbraiding his friend severely for not stopping him at the time prescribed." Daniel Webster, on being asked by a friend how it happened that he was able, without preparation, to make such a magnificent effort when he replied to Hayne, answered substantially as follows: "In the first place, I have made the Constitu-

* Myers, I, 107, summarizing art. by Binet, *L'Année Psychologique,* 1894, p. 124.

tion of the United States the study of my life; and on that occasion it seemed to me that all that I had ever heard or read on the subject under discussion was passing like a panorama before me, arranged in perfectly logical order and sequence, and that all I had to do was to cull a thunderbolt and hurl it at him."*

There is little to bear out Lombroso's theory of degeneracy. Genius sometimes shades into the abnormal, but the manner of this shading is suggestive. There is the same abstraction as in other cases of genius, the same up-rush of ideas or images, the same sense of inspiration, but the ideas or images are not co-ordinated and controlled. William Blake, for instance, was subject to visions, which he regarded as real. His later poetry is largely incoherent.

It is possible that our æsthetic judgments and other judgments of value should be classed as intuition. They frequently appear to be instantaneous, coming without any sense of effort, and not dependent on any process of reasoning. In some cases (children and savages) they do not seem to depend on education or previous association.

(b) *Sleep.* Physiologically this is the periodic recuperation of the nervous system, especially of the upper brain, and to a certain extent of the body which it controls. The temperature and blood-pressure of the brain decreases, the pulse and breathing are lowered, and there is a large reduction in the amount of carbonic acid gas given off. Mosso has shown "that there

* *Law of Psychic Phenomena,* 59-60.

are frequent adjustments in the distribution of the blood, even during sleep. Thus a strong stimulus to the skin or to a sense organ—but not strong enough to awaken the sleeper—caused a contraction of the vessels of the forearm, an increase of blood pressure, and a determination of blood toward the brain; and, on the other hand, on suddenly awakening the sleeper, there was a contraction of the vessels of the brain, a general rise of pressure, and an accelerated flow of blood through the hemispheres of the brain. So sensitive is the whole organism in this respect, even during sleep, that a loudly spoken word, a sound, a touch, the action of light or any moderate sensory impression modified the rhythm of respiration, determined a contraction of the vessels of the forearm, increased the general pressure of the blood, caused an increased flow to the brain, and quickened the frequency of the beats of the heart."* Sleep is to be distinguished from coma, which is connected with the accumulation of blood in the vessels of the brain, and from syncope, or fainting, due to a sudden weakening of the heart's action and the insufficient supply of blood.

Psychologically, sleep is the more or less complete absence of consciousness. Its intensity varies, being very much greater during the first hour. In deep sleep the ordinary mental processes are held in abeyance. At the same time there is evidence that a certain mental activity persists throughout this state. A mother, otherwise sound asleep and completely unconscious, is

* *Enc. Brit.* XXV, 239 b.

ready to wake with the stirring or cry of her baby. We have all noted the same thing in nurses, professional and amateur. A man plans to wake at a specified hour, and he does so as exactly as if he had set an alarm clock. Waking at a certain hour may become a habit. (All these points are paralleled in our waking life.) The physical changes during sleep, noted in the last paragraph, may be presumed to have a psychical accompaniment, even when there is no evidence of dreaming. The same thing is indicated by the fact that any normal sleeper will awake if disturbed by a sufficiently strong stimulus. Sleep does not interfere with the continuity of ordinary consciousness; on waking we usually begin our mental life where we left off when we lost consciousness. The same is true of syncope or deep coma from which the patient recovers. In these cases, however, the activity of the brain, and presumably of the mind, is in abeyance.

While passing to or from deep sleep, or at other times when the intensity of sleep is low, the mind is partially conscious. In this state some of our faculties may be abnormally active. We draw conclusions or solve problems, just as in "intuition." Sometimes the setting is luxuriantly appropriate, as when a Babylonian priest appeared to Professor Hilprecht and told him the meaning of two Babylonian inscriptions.* This is due to our increased visualizing power, and the dream image often persists for a few moments as a waking hallucination. Many times we go on wrestling with

* Myers, I, 376.

the questions which occupied us when we went to sleep. M. Retté, a French poet, says that he "falls asleep in the middle of an unfinished stanza, and when thinking of it again in the morning finds it completed. And M. Vincent d'Indy, a musical composer, says that he often has on waking a fugitive glimpse of a musical effect which (like the memory of a dream) needs a strong immediate concentration of mind to keep it from vanishing."* Robert Louis Stevenson's description of the dream characters who wrote his stories for him is almost exactly parallel with the waking experience of M. de Curel, already given.†

In the more common type of dream, the mind seems at first thought to be running riot. Attention and other voluntary control is wanting, there is no possibility of using the sense-organs to check illusion, inductive reasoning is unknown, the imagination has free play and anything that comes into our mind is real. But, with these limitations, the mind works about as usual. As one image calls up another, the link of association between them is based on our previous mental history, very much as in waking imagination. A large proportion of our dreams are started by some external or organic stimulus. Many experiments have been made along this line. Thus Maury says that when cologne was held to his nose he dreamed he was in Farina's shop in Cairo. A bed-pole once fell on his neck and he was in the French Revolution and finally

* *Id.*, I, 89.

† See chapter on *Dreams*, in *Across the Plains.*

guillotined. "Another class of dreams is that in which the abnormal bodily states of the dreamer are brought to his knowledge in sleep, sometimes in a symbolical form; thus a dream of battle or sanguinary conflict may presage a hemorrhage."* Sometimes dreams may be started by a suggestion made verbally to the sleeper. Other dreams are due to the apparently automatic revival of past experiences.

Memory in dreams differs in some ways from waking memory. It is less exact as to time and space relations, personal identity, etc. At the same time events may be recalled which, for the waking subject, were completely forgotten or never consciously known. We shall meet with further evidence of a mental life below the threshold of ordinary consciousness. Again, the same dream, or certain parts of it, may recur, even to the exact reproduction of some image—for example, a picture or a particular printed page. Such a feat is impossible when one is awake. On regaining full consciousness, one often remembers the dream itself, at least for a short time, and thus it fits into the continuity of mental life. Often the dream will strongly affect the physical and mental state of the individual.

Another striking psychological fact is the failure to maintain a clear consciousness of the self. Sometimes we seem to be watching ourselves, like spectators at a play. Sometimes we appear as several persons at once, an example of multiple personality. We may assume imaginary or historical characters.

* *Enc. Brit.* VIII, 560, c.

In the sense-illusions and hallucinations of waking life, the image seen or heard appears much more vivid than in the dream. According to the census undertaken by the Society for Psychical Research, at least ten per cent of all sane persons have experienced hallucinations while apparently awake and in health. These are generally visions of some familiar friend. Voices are sometimes heard. Hallucinations may be brought on by fixing the eyes on a polished surface, as in crystal gazing, also by intense hunger, by the action of certain drugs, and in the course of disease. The phenomena are undoubtedly physiological in their basis, the usual neurone processes being disturbed, or stimulated from within rather than through the senses. In some cases such inward stimulation is probably mental: with normal persons there is apt to be a previous state of expectation which predisposes the subject to the illusion or hallucination.

Persons in the dream stage of sleep are quite susceptible to motor suggestion. A sleeper when cold will draw up the cover. A child turns over when told to do so. A rider will fall asleep and still keep his seat on the horse and hold the reins. Some sleepers will answer when spoken to, and even hold extended conversations. In all these cases, as in laughter, muttering, or bodily movements, there may be an accompanying dream which is not remembered. My brother when a boy was roused to eat some ice-cream. Next morning he saw the empty plates and complained because he had not been wakened to share the treat.

This brings us to somnambulism, which might be described as a dream acted out under the impulse of a dominant idea. Sometimes the faculties of sight and hearing are active and open to impressions. The subject generally acts without speaking. The somnambulist may go through customary actions, write a letter, play on a musical instrument, walk in dangerous places, or even commit an immoral act. Like most other dreams involving bodily movement, this is not remembered on waking.

(c) *Hypnosis.* Here certain phenomena occurring in ordinary consciousness, in dreams or in the abnormal, appear in high relief and under experimental control. By suggestion or the fixing of attention, the patient is put into a condition in some ways resembling sleep, where he is peculiarly susceptible to "suggestion." He readily accepts the idea or command given him by the operator. In the lighter stages, the hypnotized person is aware of what goes on. The only change is in the control over voluntary movements. For example, he will raise his arm in imitation of the operator or in obedience to his command, and he cannot let it down until told that he is able to do so. In deep hypnosis the patient is not conscious. He is almost completely under the operator's control. Sense illusions and hallucinations are readily induced—especially the former. If told that a third person is not present, the patient ignores his presence. If told that a piece of cloth is a kitten, he begins to stroke it. Hypnotics will act a suggested part with great skill, even the part of an animal or inanimate object. Motor suggestions are carried out just as in somnambulism. On the other hand, the inhibition of movement may resemble the rigidity of catalepsy and last for a number of hours. Total or partial loss of sensation may be induced. The power of the senses may be inhibited, or greatly increased. A patient has been known, without a microscope, to see and draw cells only .06 mm. in diameter.

Hypnosis, though parallel in some ways to the nervous disease of hysteria, does not appear to be a pathological condition. Pulse and breathing are generally normal, or slightly lowered as in deep sleep. Without special suggestion, the power of both senses and muscles is somewhat less during hypnosis. There is seldom any noticeable fatigue, even when the same position is maintained for a long time. Practically any normal person may be hypnotized, under favorable circumstances. If mild methods are used in inducing hypnosis and sufficient care is taken in waking the patient, there appear to be no harmful effects, as is also the case with somnambulism.

The dissociation of consciousness has been given a physiological explanation. I will briefly outline the theory, although it must still be regarded merely as a working hypothesis. Through the contact of axones and dendrites, cells become organized into groups and series, which are more or less stable, according to their complexity, the date of their formation and the frequency of their use. An unusual stimulus—for example, a poison, a blow or a strong emotion—causes the association fibres to contract and thus break contact between the cells. The more complex associations which have been formed are the first affected. The cell itself remains intact until we reach the stage of insanity. In normal consciousness, the various trains of nerve impulses, and so of ideas, modify one another. In sleep, hypnosis or the abnormal, the more delicate association paths are blocked. The nervous impulse will follow the simpler cell-connections, without interference from parallel series of associated cells. The psychical result is that each group of ideas, when excited, tends to work itself out without interference and to become realized in action. Hypnosis would thus be merely "a temporary functional depression" of many or all of the nerve-cells.

All persons are more or less susceptible to suggestion, without hypnosis. If one says to an embarrassed person, "You are getting red in the face," he generally starts to blush. Paralysis and other physical effects may be brought on by suggestion in the waking state. In many cases the suggestion must be carefully veiled, as Sidis has pointed out. The suggestion may come from the subject himself; he may be unable to use his limbs because he has convinced himself that he cannot do so. The stammerer who talks perfectly well when he forgets his impediment, but begins to stammer as soon as he thinks of stammering, is another case of auto-suggestion. It is not easy to draw the line between suggestion in the waking state and suggestion in light hypnosis. Even the "rapport" between operator and patient finds a close parallel in the influence of one personality over another in ordinary life.

To illustrate the physical effects brought on by a dominant idea, I cite the classic case of Louise Lateau, which may have been hypnotic, though it is not usually so classed. A number of similar cases are known. "This young Belgian peasant had been the subject of an exhausting illness, from which she recovered rapidly after receiving the Sacrament; a circumstance which obviously made a strong impression on her mind. Soon afterward, blood began to issue every Friday from a spot on her left side; in the course of a few months, similar bleeding spots established themselves on the front and back of each hand, and on the upper surface of each foot, while a circle of small spots formed on the forehead; and the hemorrhage from these recurred every Friday, sometimes to a considerable amount. About the same time fits of 'ecstasy' began to recur, commencing every Friday between 8 and 9 A. M., and ending about 6 P. M., interrupting her in conversation, in prayer, or in manual occupations." When she recovered, she distinctly remembered what had passed through her mind during the "ecstasy." She had witnessed the passion of the Lord and "minutely described the cross and the vestments, the wounds, and the crown of thorns about the head of the Savior."*

For a case of stigmatization under hypnosis, I cite an experiment of Professor Forel on an attendant in

* Wm. B. Carpenter, *Mental Physiology,* 1876, p. 689.

the Zürich Asylum. With the point of a blunt knife he drew two light crosses on her chest. "They did not bleed. Another cross was made on the inner side of each forearm. Several doctors were present. Forel suggested the appearance of blisters on the right side. Even at the end of the five minutes, during which Forel watched the subject, so that fraud was out of the question, a considerable reddish swelling of the skin had appeared. A wheal, looking like nettle-rash, had formed itself round the cross, somewhat in the shape of a cross. On the left side nothing was to be seen but the cross that had been drawn, unaltered. The wheal on the right side resembled a vaccination pustule, in the form of a cross; but it was simply a papular swelling, as in nettle-rash."* A case of stigmatization due to a dream is given by Dr. Krafft-Ebing.†

The power of memory is ordinarily somewhat weakened in hypnosis. It may, however, be specially stimulated by suggestion, and there are other cases of unusual power of recollection. Languages learned in childhood and since forgotten may be revived. There is the celebrated case of the ignorant servant girl who burst into Hebrew, which she had heard when young in a clergyman's home. Ignorant fanatics, when in an ecstasy, have been known to repeat carefully-constructed religious addresses.

On waking from light hypnosis the patient remembers what has taken place during the trance. In some-

* Albert Moll, *Hypnotism,* p. 136.
† See Myers, I, 127.

what deeper stages a dim memory may persist; the events may be recalled by some association of ideas. The most striking fact about deep hypnosis is that during this state the patient remembers not only the events of his waking life, but the events of previous hypnotic states, of which he knows nothing when awake. If playing a certain character, however, he only remembers his hypnotic experiences in that character. Forgotten dreams are sometimes recalled in hypnosis, and, *vice versa,* hypnotic experiences may recur in dreams. The impressions of the hypnotic state, although not consciously remembered, will reappear, as in automatic writing, or when the subject is commanded by the previous operator to remember,* or in what are known as post-hypnotic suggestions. A patient on waking will carry out commands which have been given, and perhaps invent some plausible reason for so doing. If told he will itch when he wakes, the subject will itch. If told he will dream certain things, he subsequently dreams them. Suggestion will cause a patient to forget certain facts or events, and this loss of memory may persist for a considerable time. Sense-delusions and hallucinations in the waking state may be induced in the same way. There is evidence that in some cases the carrying out of a post-hypnotic suggestion is really a new hypnosis, the patient being susceptible to further suggestions and unconscious of his acts. The patient may appear sleepy or uneasy until the suggestion is carried out. After light hypnosis the patient may real-

* Boris Sidis, *Psychology of Suggestion,* 1898, p. 119.

ize the source of his constraint and still be unable to resist.

The hypnotic subject is far from being an automaton. His will resists in various ways. "The more an action is repulsive," says Dr. Moll, "the stronger is his resistance. Habit and education play a large part here; it is generally very difficult to suggest anything that is opposed to the confirmed habits of the subject. For instance, suggestions are made with success to a devout Catholic, but directly the suggestion conflicts with his creed it will not be accepted. The surroundings play a part also. A subject will frequently decline a suggestion that will make him appear ridiculous. A woman whom I put into cataleptic postures, and who made suggested movements, could not be induced to put out her tongue at the spectators. In another such case I succeeded, but only after repeated suggestions. The manner of making the suggestion has an influence. In some cases it must be often repeated before it succeeds; other subjects interpret the repetition of the suggestion as a sign of the experimenter's incapacity and of their own ability to resist."* A repugnant suggestion may lead to the request to be awakened, or even to an attack of hysteria.

Hudson has pointed out the fact that inductive reasoning is unknown in dreams or in hypnosis. The mind is open to suggestion but not to doubt. The patients cannot argue. To deny one of their statements throws them into confusion, and often awakens them,

* *Hypnotism,* 188.

with a severe nervous shock. This is undoubtedly due to the fact that the denial is a counter-suggestion to the one under which they are acting. The subject will, however, follow out every idea to its logical conclusion. A suggested introduction to Socrates caused a cultured young man of Washington to converse with the sage for over two hours, developing a philosophy of "spiritism" quite opposite to his materialistic waking beliefs. When other characters were introduced, the diction changed, but the philosophy was the same, being based on the same assumption of a returned spirit.*

Another author says: "It is often necessary to suggest a false premise to the subject before he will do what is wanted. X cannot be induced to spill a glass of water in my room, but when I tell him that the room is on fire he does it at once."†

(d) *Double and Multiple Personality.* I begin with the classic case of Félida X, to which nervous pathology has since added many parallels. "Félida was a native of Bordeaux, the daughter of a sea captain, and until her thirteenth year seemed like any normal child. Then, however, she manifested tendencies to hysteria, and a little later fell periodically and quite spontaneously into a trancelike condition, out of which she would emerge the possessor of characteristics radically different from those of her normal self. Oddly enough, the secondary Félida was a conspicuous im-

* *Law of Psychic Phenomena,* 36.

† Moll, *op. cit.* 178.

provement over the primary Félida, who was of a melancholy, fretful, and taciturn disposition, whereas the trances left her buoyant, vivacious, and social. What was still more striking, when in the secondary state she had a clear memory for all the events of both states, but when her normal self knew nothing of the happenings of the secondary condition. Before she was fifteen the alternations of personality occurred so often that her parents called in a physician, Dr. Azam, of Bordeaux, who has left a graphic account of her mysterious history. Every means was tried in vain to check the recurrence of her 'crises,' but happily her malady ultimately worked its own cure. Little by little the secondary state gained command over the primary, until the latter finally appeared only at rare intervals, and the patient thus became a new woman in the strictest sense of the term. In no way did she suffer inconvenience save when lapsing into her primary self, for each such lapse meant a loss of memory for the occurrences of a now lengthy period. 'She then,' we are told, 'knew nothing of the dog that played at her feet, or of the acquaintance of yesterday. She knew nothing of her household arrangements, her business undertakings, her social duties.' Making a virtue of necessity, Félida accustomed herself whenever she felt the premonitory symptoms of an attack, to write letters to her other self, giving full directions as to the conduct of her domestic and social affairs, and in this way she was enabled to bridge the gap in memory to some extent. It was in 1858 that Dr. Azam first studied her, and when he last reported on her case, in 1887, she was married, was the happy mother of a family, and was constantly in the secondary state, excepting for lapses of but a few hours' duration occurring only six or seven times a year."*

We have seen the ease with which different personalities are assumed in sleep and in hypnosis. Dr. Boris Sidis and others have used hypnosis (and the intermediate "hypnoidal" state) in cases of secondary personality. Their object is partly to learn the previous history of the patient and partly to effect a cure by suggestion. We may take the case of Rev. Thomas C. Hanna. For convenience I again use the summary given by Bruce.

"Mr. Hanna, in the spring of 1897, was plunged into a state of complete amnesia as the result of a fall from a carriage. He lost all sense of identity, forgot the events of his past life, had no sign of recognition for relatives and friends. More, he had to be taught to read, to write, even to talk and walk and eat. It was at first thought that his future home would have to be in an asylum, but as time progressed and he displayed the possession of a keen, vigorous, intelligent personality, his case was referred to Drs. Sidis and Goodhart in the hope that they might succeed in recovering the lost contents of his consciousness. Their immediate concern was to learn whether any memory of events antedating the accident persisted in a subconscious, dissociated state. Resort is usually had to hyp-

* H. Addington Bruce, *Riddle of Personality,* 1908, p. 62.

notism for this purpose, but it was found impossible to hypnotize Mr. Hanna. However, hypnoidization . . . convinced Drs. Sidis and Goodhart that the lost memories survived, and the effort was now made to bring them permanently into the field of waking consciousness. The experiment was tried of conducting the patient to theaters, saloons, and other places of entertainment to which, in his normal state, he would not think of resorting. It was hoped that there might result a reintegrating, reassociating shock, and this hope was actually realized. One night there developed a spontaneous but brief recurrence of the original personality. The experimenters persevered, and soon witnessed the phenomenon of alternating personality. One moment the patient would be the Mr. Hanna of old, the next the secondary Mr. Hanna. He was ceaselessly urged to try to remember in each personality the thoughts, feelings, actions of the other. Memory was to be the bridge across the chasm separating the two personalities. Ultimately, complete fusion was effected and the clergyman restored to his family, a normal, healthy man."*

The trance medium develops a number of alternate personalities. Thus Mrs. Piper believed herself and gave every external evidence of being in communication with departed "spirits." At first she impersonated a French doctor named Phinuit, later a Boston lawyer generally known as George Pelham and then a group

* *Id.*, 102. For a full description of the case see Sidis and Goodhart, *Multiple Personality*.

of "controls" (Imperator, Rector, Doctor, Mentor and Prudens) which had been prominent in the case of an earlier medium. When Dr. Hyslop began to investigate the case, the spirit of his father made its appearance, and then the spirit of a previous investigator, Dr. Hodgson. The only real difference between this case and that of the hypnotized Washington lawyer conversing with Socrates is the extraordinary knowledge of events sometimes shown by the medium. To this problem I shall return in the closing section of the chapter.

(e) *The Subconscious.* The foregoing groups of phenomena may be strung on a single thread. They prove the existence of a field of mental life below the threshold of ordinary consciousness, a field whose activities and experiences are not recognized in our waking moments. Let me put together, at the cost of repetition, some of the things which modern investigation has shown regarding this subconscious mind.

A subconscious mental life is practically continuous in adults; it goes on as long as "cerebration" goes on. There is no clear evidence for subconsciousness in syncope or coma, when the activity of the brain is inhibited. But we find it in deep sleep. The sleeper retains a time-consciousness, a responsiveness to cries or other signals. We find the subconscious in catalepsy and deep hypnosis. We find it in our waking hours: whenever a person is conscious, he is at the same time subconscious. Impressions are received and activities undertaken of which the person has no knowledge, in the ordinary sense. To give only one of the many lines of evidence, Binet had a patient read a journal, in which he soon became absorbed. Then very gently he caused the patient's right hand to execute (in complete unconsciousness) certain movements, such as those involved in forming spirals or making dots. After a few minutes the hand, left to itself, kept on tracing the movements which had been learned. That is, the subconscious personality could be taught to write, very much as the conscious personality. After three thousand laboratory experiments, with the same result, Dr. Sidis speaks of the life of the waking self-consciousness as flowing within the larger life of the subwaking self "like a warm equatorial current within the cold bosom of the ocean."*

This subconscious mind emerges above the threshold of consciousness in our remembered dreams and in waking hallucinations. It may be brought out experimentally in hypnosis. It is to the subconscious that the mental healer makes his appeal. To it are probably due the "intuitions" of genius or of the ordinary man, the achievements of the calculating boy, the behavior of the somnambulist or of the person in a sudden crisis. To the subconscious is undoubtedly to be credited much of the training of mind and character.

For the subconscious mind, as we know it, changes of personality are kaleidoscopic. In our dreams we are now Napoleon, now a coal-heaver, now one person, now several persons, now an animal or an inani-

* *Psychology of Suggestion*, 162.

mate object. So in hypnosis, according to the operator's whim. One of these fleeting characters may emerge and become fixed as a secondary personality, taking the place of the normal personality or alternating with it. Beneath whichever personality is enthroned in consciousness, the stream of the subconscious flows on. Ideas and groups of ideas may become fixed in the same way, as frequently in hysteria. A patient may become afraid to cross an open space or to sit in a closed room. He may suddenly develop a mania for stealing: one of Janet's patients even stole from himself. Such ideas arise within the subconscious mind, and are often removed by an appeal to the subconscious.

Memory in the subconscious life is encyclopædic. It includes all that ever enters our conscious memory and a great deal more. There is some evidence that all we have consciously perceived or experienced since early childhood, and much to which we paid no attention at the time, is here permanently registered. In revery, hypnosis, secondary personality, we may draw from deeper levels of this record than we do in deliberate recollection. Thus one of Dr. Breuer's patients, Miss Lucy P., had a hallucinatory smell of burnt pudding, and also of tobacco smoke. Careful inquiry proved that in each case the smell made up part of the setting of a scene in which her emotions had been strongly stirred.* Probably all memory is to be considered as subconscious; waking recollection is merely a selection

* Breuer and Freund, *Studien über Hysterie,* summarized in Myers, I, 51 *ff.*

by the conscious personality from the stores beneath the threshold.

The most striking characteristic of the subconscious field is its suggestibility, its plasticity, its readiness to fall in with any idea strongly impressed upon it. Dr. Sidis has proved the identity of normal and abnormal, of waking and sleeping suggestibility. "It is the subwaking, the reflex, not the waking, the controlling, consciousness that is suggestible. Suggestibility is the attribute, the very essence of the subwaking, reflex consciousness. . . . Abnormal suggestibility varies as direct suggestion, and inversely as indirect suggestion. Normal suggestibility varies as indirect suggestion, and inversely as direct suggestion. These two laws are the reverse of each other, thus clearly indicating the presence of a controlling inhibitory conscious element in the one case, and its absence in the other. In the normal state we must guard against the inhibitory waking consciousness, and we must therefore make our suggestion as indirect as possible. In the abnormal state, on the contrary, no circumspection is needed; the controlling, inhibitory waking consciousness is more or less absent, the subwaking reflex consciousness is exposed to external stimuli, and our suggestions, therefore, are the more effective the more direct we make them."*

Communication between the conscious and subconscious mind is more or less continuous. All experiences of the conscious are registered as memories in the subconscious. In our waking state we make many sug-

* *Psychology of Suggestion,* 89.

gestions to the subconscious: that we shall wake at a given hour, that we shall succeed in a certain interview, that we shall break down, that we shall feel pain, that we shall be free from pain. The conscious self imposes many inhibitions on the subconscious, as remarked above.

Still more numerous are the communications from the subconscious to the conscious: as revived memories, as automatic movements, as sensory inhibitions or stimuli, as post-hypnotic suggestions, as emotions, manias, hallucinations, as problems solved or stories written, as motives changed and characters altered. At other times, when the conscious mind is distracted or in abeyance, the subconscious may carry out its own suggestions.

Sidis, following Liébault, who made a special study of hypnotism and crime, claims that "the subwaking self is devoid of all morality; it will steal without the least scruple; it will poison; it will stab; it will assassinate its best friends without the least scruple. When completely cut off from the waking person it is precluded from conscience."*

Later studies have cast doubt on this picture. It is a question whether any but trained hypnotic subjects will do the things mentioned; they are acting a part, just as they would be in stabbing or poisoning a friend on the stage. The hypnotic does not surrender control; suggestion, to be effective, must become auto-suggestion. It is doubtful if the conscious and the sub-

* *Id.*, 295.

conscious can be separated as sharply as Sidis would have us believe. Much of the activity of "the conscience" goes on below the threshold. The subconscious is a large, perhaps the largest, element in our normal training in morals. Again, the secondary personality accidentally or deliberately evolved from the subconscious is quite apt to be an improvement. Especially is this the case where a third or fourth personality appears, apparently from a deeper level. Thus the melancholy Mary Reynolds becomes gay and flighty in her secondary personality; in her third and final stage she is described as becoming "rational, industrious, and very cheerful, yet reasonably serious; possessed of a well-balanced temperament, and not having the slightest indication of an injured or disturbed mind."* Dr. Bramwell says of hypnotics: "Any changes in the moral sense have invariably been for the better, the hypnotized subject evincing superior refinement."† But we as yet know too little about the subconscious to discuss its morals.

Much the same things may be said as to the intelligence of the subconscious, which is rated low by Sidis and others. Because of its inclusive memory, our subconscious mind is largely a rubbish heap, and many public exhibitions of it resemble the work of a ragpicker. But in the thought-life of the average man, not to speak of the genius or the prodigy, a large and important part goes on below the threshold. The per-

* James, *Psychology,* I, 383.

† Myers, I, 517.

fectly-trained mind is the one which commands the full resources of the subconscious. The mental work done in sleep or hypnosis is often superior to that of our waking hours. The subconscious mind may not be capable of induction or argument. But one hesitates to criticize the intelligence which can write Stevenson's stories, reply to Hayne, or solve a difficult problem in paleography. The subconscious possesses a remarkable power of calculating the passage of time. Its discriminating attention is shown in many ways, notably by the hypnotized nurses in Dr. Forel's asylum. "The nurse's bed is placed at the side of the patient's, and the suggestion is given that she shall sleep well and hear nothing except any unusual sound the patient may make. If the latter atempts to get out of bed, or to do herself any harm, the nurse awakes at once, otherwise she sleeps soundly, despite the unimportant noises and movements made by the patient."* In the subconscious, as we know it, almost any power of the senses or of the mind may be heightened, if the proper impression is made on the subject.

A question of great importance is the relation of the subconscious mind to the physical organism. The subconscious can do everything that the conscious mind is capable of, in the control of fingers, limbs, etc., and generally do it better; the somnambulist furnishes a good example. It can do many things which are impossible for the conscious will. On this depends the value of suggestion in therapeutics. The subconscious

* See Myers I, 512.

is able to inhibit many reflexes, such, for example, as those ordinarily following an odor, taste, touch or pain. The secretion of certain glands is known to be under its control. The temperature of the body or its parts may be raised or lowered by suggestion. The subconscious controls the circulation of blood to given parts of the skin, causing blisters or hemorrhage, as in the many cases of stigmatization. Similarly, hemorrhages may be stopped through suggestion, and various skin diseases cured—for example, eczema. One of Delboeuf's cases illustrates both this control of the circulation and the usual subconscious method of producing insensibility to pain, through the diversion of attention rather than by the deadening of the nerves. A young woman was hypnotized and told that she would feel no pain in her right arm. "Each arm was then burnt with a red-hot bar of iron, 8 mm. in diameter, the extent and duration of its application being the same in both, but pain being felt in the left arm alone. The burns were bandaged and J. was sent to bed. During the night the pain in the left arm continued, and next morning there was a wound on it, 3 cm. in diameter, with an outer circle of inflamed blisters. On the right there was only a defined eschar, the exact size of the iron and without inflammation or redness. The day following the left arm was still more painful and inflamed; analgesia was then successfully suggested, when the wound soon dried and the inflammation disappeared."*

* See Myers, I, 470.

The fact that the range of the senses may be greatly increased in the subconscious state suggests the possibility of new and hitherto unsuspected powers of sense. Thus the hypnotic can distinguish between different people present in a room, possibly recognizing them by smell as certain animals would do. Similarly, we have "rose asthma," and the sense of a cat in the room. Professor Barrett has made a careful study of the so-called "divining rod," and proved that there exists in many persons a sensitiveness to running water in proximity.* A sensitiveness to magnets has not yet been established, though there is some evidence for it. The somnambulist sometimes has a sense of locality almost resembling that of the carrier pigeon.

Turning to more doubtful cases, we have Fontan's careful experiments on a hypnotized sailor at Toulon. He was blindfolded and told he could see only with his fingers; any other part would probably have served the same dramatic purpose. But the patient was actually able to distinguish letters, colors and pictures.† No lens was available for the act of seeing. Apparently this is a case either of telepathy (see section *f* below), where the patient read the operator's mind, or of a power of perception independent of our usual sense organs. In many cases of trance, there seems to be a knowledge of facts or distant scenes which cannot be explained even by telepathy. But the evidence for second sight is still anecdotal rather than experimental.

* See *Proceedings S. P. R.*, XIII, 2 *ff;* XV, 130 *ff.*

† *Id.*, V, 263.

(f) *Telepathy.* Evidence has been accumulating for the possibility of communication between one mind and another without the use of the ordinary channels of sense. The opening up of this rich field, long abandoned to superstition and fraud, has been due to Edmund Gurney and the remarkable group of observers associated with him in the Society for Psychical Research.

Repeated experiments have shown that simple sensations such as tastes and pains may be transferred by telepathy with a fair degree of accuracy. The same is true of visual images, such as numbers or letters. In a series of experiments carried on by Mr. Guthrie of Liverpool, two young ladies being used as percipients, in three hundred and eighty-seven cases out of four hundred and fifty-seven something was perceived. The descriptions of three hundred and nineteen of these were wholly or partially correct.*

An experiment by Dr. Thomas Jay Hudson may be taken as an illustration. He caused himself to be blindfolded in the presence of his family and two or three trustworthy friends, and "instructed them to draw a card from the pack, place it upon a table, face up, and in full view of all but myself. I enjoined absolute silence, and requested them to gaze steadily upon the card and patiently await results. I determined not to yield to any mere mental impression, but to watch for a vision of the card itself. I endeavored to become as passive as possible, and to shut out all objective

* Frank Podmore, *Thought-transference,* 1894, p. 33.

thoughts. In fact, I tried to go to sleep. I soon found that the moment I approached a state of somnolency I began to see visions of self-illuminated objects floating in the darkness before me. If, however, one seemed to be taking definite shape it would instantly rouse me, and the vision would vanish. At length I mastered my curiosity sufficiently to enable me to hold the vision long enough to perceive its import. When that was accomplished, I saw—not a card with its spots clearly defined, but a number of objects arranged in rows and resembling real diamonds. I was finally able to count them, and finding that there were ten, I ventured to name the ten of diamonds. The applause which followed told me that I was right, and I removed the bandage and found the ten of diamonds lying on the table. The vision was symbolical, merely, but no possible symbol could have conveyed a clearer idea of the fact as it existed."*

Telepathy is even more successful in hypnosis. Thus, in the transference of pain, we may quote a series of trials conducted by Gurney and others on the evening of January 4th, 1883. A youth named Wells was hypnotized by Mr. G. A. Smith. Wells was blindfolded, and Mr. Smith stood behind his chair, holding one of his hands.

"1. The upper part of Mr. Smith's right arm was pinched continuously. Wells, after an interval of about two minutes, began to rub the corresponding part on his own body.

* *Evolution of the Soul,* 188.

"2. Back of the neck pinched. Same result.
"3. Calf of left leg slapped. Same result.
"4. Lobe of left ear pinched. Same result.
"5. Outside of left wrist pinched. Same result.
"6. Upper part of back slapped. Same result.
"7. Hair pulled. Wells localized the pain on his left arm.
"8. Right shoulder slapped. The corresponding part was correctly indicated.
"9. Outside of left wrist pricked. Same result.
"10. Back of neck pricked. Same result.
"11. Left toe trodden on. No indication given.
"12. Left ear pricked. The corresponding part was correctly indicated.
"13. Back of left shoulder slapped. Same result.
"14. Calf of right leg pinched. Wells touched his arm.
"15. Inside of left wrist pricked. The corresponding part was correctly indicated.
"16. Neck below right ear pricked. Same result."*

The evidence for telepathy at a distance is less complete, but still fairly satisfactory. Janet and Gilbert tried to induce hypnosis at a distance. Out of twenty-five trials on the same patient, eighteen were a complete success and four others partial or doubtful.† In a second series of thirty-five experiments, sixteen were successful and two doubtful. Striking results have been obtained by other workers. Hudson claimed

* Podmore, *op. cit.*, 60.
† *Id.*, 112.

great success in the treatment of disease by telepathic suggestion.*

Some successful attempts have been made to cause hallucinations, in most cases an image of the operator himself. An experiment by Rev. Clarence Godfrey will illustrate this. On a certain evening he determined to appear if possible to a friend, "and accordingly I set myself to work with all the volitional and determinative energy which I possess, to stand at the foot of her bed." No hint had been given to the lady. His efforts continued for perhaps eight minutes, after which he felt tired and went to sleep. Next morning at 3:40 he met the lady in a dream. The account written by the lady herself is as follows: "Yesterday about half-past three o'clock, I woke up with a start and an idea that some one had come into the room. I heard a curious sound, but fancied it might be the birds in the ivy outside. Next I experienced a strange restless longing to leave the room and go downstairs. . . . On returning to my room I saw Mr. Godfrey standing under the large window on the staircase. He was dressed in his usual style, and with an expression on his face that I have noticed when he has been looking very earnestly at anything. He stood there, and I held up the candle and gazed at him for three or four seconds in utter amazement, and then, as I passed up the staircase, he disappeared." Two out of three experiments of the same sort were successful.†

* *Law of Psychic Phenomena,* 191 *ff.* More than a hundred experiments were made.

† Podmore, 228.

The Society's records are filled with cases of spontaneous hallucinations, generally perceived by a single individual, though sometimes by two or more persons. In the census undertaken in 1889, questions were put to 17,000 normal adults, chosen at random. Practically ten per cent (1,684 persons) had experienced waking hallucinations. Of these apparitions three hundred and fifty were recognized as those of living persons. The proportion of death coincidences, that is, apparitions seen within from one to twelve hours of the death of the persons visualized, was placed by the Society's committee at one in forty-three. As Myers puts it: "Since the average annual death-rate in England and Wales is 19.15 per 1,000, the probability that any one person taken at random will die on a given day is 19.15 in 365,000, or about 1 in 19,000. This may be taken as the general probability that he will die on the day on which his apparition is seen and recognized, supposing that there is no casual connection between the apparition and the death. In other words, out of every 19,000 apparitions of living persons there should be by chance one death coincidence. But the actual proportion found, viz., 1 in 43, is equal to about 440 in 19,000, or 440 times the most probable number. . . . This is the case if we take, as we have done, death coincidences to mean an apparition occurring within twelve hours of the death of the person seen. But the great majority of the coincidences are believed by the percipients to be closer than this, and the improbability of the apparition occurring by chance within an hour of the death is of course twelve times as great."*

The simplest explanation of these phenomena is that which considers them as cases of telepathic communication between the dying persons and the percipients. The same explanation may be given to "ghosts" and to clairvoyance.

We as yet know little about the conditions under which telepathy operates. It seems to be connected with the subconscious portion of our mental life. Communication is most frequent between those allied by ties of blood or friendship, but it is possible between mere acquaintances and even between strangers. As in hypnotism, the idea or image transmitted may remain for a considerable time below the threshold of consciousness, until sleep or other favorable circumstances bring it to the surface.

Let us glance a moment at clairvoyance. Either through dreams or by gazing at a piece of crystal or a similar object which serves to focus the hallucination, or through a trance of some sort, the medium is able to give facts or pictures of which she (I am thinking of Mrs. Piper) could have no previous knowledge. Sometimes these facts are evidently extracted from the subconscious minds of the persons present. Occasionally the information conveyed by "Phinuit" or some other control appears to transcend the knowledge even of those in the room. It might be conveyed telepathically to the sitter by some one at a distance, and by

* Myers, I, 573.

him to the medium. There is no valid reason for considering "Phinuit" and the rest as spirits from another world. Again I must appeal to the law of parsimony. The facts supply their own explanation—a telepathic one. That explanation is entirely satisfactory as a working hypothesis. To seek another and more elaborate explanation is logical extravagance.

CHAPTER XV

A NEW DEFINITION OF PERSONALITY

WHAT is personality? This is the next philosophical problem we must face. In a previous section I referred briefly to organic personality, the unity of the individual organism. Professor Loeb and others have made a good deal of the segmental character of the vertebrate nervous system, and the fact that each segment continues to be a more or less independent unit. "It will perhaps make our task easier," he says, "if we conceive the segmented animal to be a colony of as many individuals or animals as there are segments (or ganglia) present in the body. Each segment is then comparable to an Ascidian in which the central nervous system consists of but one ganglion. The fibers and cells of each ganglion form for the corresponding segment a protoplasmic bridge between the skin and muscles. A stimulation beginning, however, in one segment is not confined to that segment, for the single ganglia of the various segments are connected with each other by means of nerve-fibers, the so-called longitudinal commissures. By means of these, a stimulation which originates in one segment is transmitted also to the neighboring ganglia and from these to those farther away, until at last it reaches the end of the animal."* According to this theory the brain is simply

* *Comparative Physiology,* 82.

a segmental ganglion, not an organ of a higher order that regulates and guides the activity of the other ganglia.

Important as this idea is in the study both of organs and functions, it must not be carried farther than the facts warrant. The higher vertebrate is something more than a colony of segments. It is an organism, a biological unit. No single "metamere" can live apart from the others. Portions of the original segments have been transferred, fused, eliminated, specialized.* The skeleton, skin and tissue are organized to serve the entire body. The various parts of the body are served by the same fluids, formed and circulated by specialized segmental organs. The organism is integrated still more through the development and training of the nervous system. Certain segments, through their specialization as the ganglion of the distance-receptors, come to initiate those reflex movements by which the organism is poised or operated as a whole.†

The loss of a segment from the human body is simply the loss of a group of cells which may be more or less essential to the mechanism. The segmental character of the nervous system has about as little bearing on the problem of personality as the segmental character of a railway train or a modern office building. Where there is a complete machine at the service of the mind, we find it capable of discharging certain mechanical functions. For practical purposes, the myr-

* *Cf.* Enc. Brit., art. *Metamerism.*

† *Cf.* Sherrington, *Nervous System,* 314 *ff.*

iad cells act as a unit and not merely as individuals, or as parts of organs or segments. This unity does not reside in any one segment, but in the organism as a whole, or in such portion of the organism as is able to maintain life. The dead organism ceases to be a unit, in the biological sense, or, to speak more strictly, breaks up into a number of temporary units—that is, into organs and cells. Parts of the body may live for a considerable period after the body as such is dead.

A number of lines of evidence point to the fact that the biological unity of the human organism is essentially a psychical unity. There is first the evidence (summarized in Chapter XIII) that the mental organizes and controls the physical. Second, we have seen that the integration of the human body, as a machine for doing work, is due chiefly to the reflexes started in the cerebral hemispheres, with which portion of the brain consciousness is specially associated. Third, in the constant renewal of the organism such psychological phenomena as memory, self-consciousness, etc., while making use of the mechanism of nerve-cells, may outlast several generations of nerve-cells, or at least the recasting of their physical materials. I have not the same body which I had in my eighth year—it is doubtful if any particle of it is the same—but I still remember a scene that occurred in my eighth year.

What can we say about this psychical unity, on which the unity of the living organism seems to depend? Until within a few years the answer would have been substantially that of Descartes: "I think, therefore I am." A distinct human personality in each organism is evidenced by memory, self-consciousness, the sense of personal identity. Today it would perhaps be more correct to say: "I am subconscious, therefore I am." What have we learned through our study of the abnormal? What changes is it necessary to make in the classic picture of the ego? A new continent has been discovered, but it is little explored. We know just enough to serve as a warning against hasty generalizations.

It is evident that the "person" of the older psychology remains a fact, a fact with which philosophy must reckon. Our description of the abnormal did not necessitate any revision of our chapter on the normal. In our waking hours, from early childhood to the grave (or as long as we continue normal), we are conscious: of many bodily processes, of objects discovered through our distance-receptors, of many of our mental states; we are able to control our muscles, to experiment, feel, learn, think, accomplish; we can recall experiences that have come to us through a long series of years, and identify them as belonging to the past of our own selves. This waking "personality" appears to be man's most distinguishing characteristic, shared only to a very limited extent by lower species. It is associated particularly with the specialization of the upper brain as the ganglion of the distance-receptors. Consciousness is directly dependent on the blood supply of the brain. It is this personality which gives the charm to social intercourse, which is at the basis of accountability in ethics and law. The frequent interruptions of consciousness seldom interrupt the continuity of the conscious life.

At the same time this person or ego is not as fixed a quantity as we used to think. It is slowly evolved in childhood, subject to constant modification during youth and maturity, and generally enters on a process of degeneration after middle age. During sleep—that is during at least one-third of the individual's life—its activities are suspended; the ego of the older psychology is practically non-existent. The same condition may be brought about by artificial means. Even in waking hours the ego is largely at the mercy of the subconscious. In extreme cases, the waking personality undergoes a sudden and complete change. Two distinct personalities may alternate, as in the case of Félida X, or may even coexist and struggle for the mastery, as in the case of "The Misses Beauchamp," described by Dr. Morton Prince. Which should we call the ego—the original Miss Beauchamp, or the Miss B. who appeared after a nervous shock in 1893, or the somnambulistic "B. II," or the tyrant Sally, or the "B. IV" who appeared, Rip-van-Winkle-like, in 1899 through a reintegrating shock, or the composite of "B. I" and "B. IV" formed by suggestions given to "B. II"?

Such rival egos in the waking state are rare. In the subconscious they are of frequent occurrence. Janet's experiments with hypnotics show us personality in the making. The patient will act a part suggested; at another session the part will be taken up again, until a distinct personality is formed, which, under favorable circumstances, might emerge as a secondary Félida or a Sally Beauchamp. Thus Mme. B., ordinarily known as Léonie, becomes Léontine in the hypnotic state, a very different character. "Mme. B. has been so often hypnotized, and during so many years, that Léontine has by this time acquired a very considerable stock of memories which Mme. B. does not share. Léontine, therefore, counts, as properly belonging to her own history and not to Mme. B.'s, all the events which have taken place while Mme. B.'s normal self was hypnotized into unconsciousness. . . . Mme. B., in the normal state, has a husband and children. Léontine, speaking in the somnambulistic trance, attributes the husband to 'the other' (Mme. B.), but attributes the children to herself. . . . At last I learnt that her former mesmerizers had induced somnambulism at the time of her *accouchements;* Léontine, therefore, was quite right in attributing the children to herself; the rule of partition was unbroken, and the somnambulism was characterized by a duplication of the subject's existence."* Léontine, in turn, has an unconscious stratum. Out of this emerges in time a third personality, Léonore, who gives good advice to both the others and remembers the experiences of both.

Two things are clear, it seems to me. The first is that personality, in the sense to which we have been accustomed—the consciousness of the self, the sense

* *Revue Philosophique*, March, 1888, quoted by Myers, I, 322 *ff.*

of personal identity, the memory of past experiences of the same self,—is the playing of a part. This is certainly true of Léontine, of the secondary Félida, of Sally Beauchamp. It seems to be equally true of the ordinary waking personality. Waking recollection, for instance, is merely a selection by the conscious personality of material appropriate to the part it is playing. Mme. B. knows only her waking experiences as a rather stupid peasant woman, nothing of the experiences of the clever Léontine. The longer we play a part the more definite and full it becomes. Ordinarily, for two-thirds of the time, this part is that of the waking self, which, by making use of the distance-receptors, adjusts itself more or less successfully to the physical and social environment of the organism.

Second, personality evidently must be given a broader meaning. Better still, some broader term should be used to include both the conscious and subconscious mental life of the individual. Almost any term is open to objection, but I choose "mind" as the word least likely to involve us in entangling alliances.

What can we say of the human mind, in this broad but definite sense? It includes all the life of the waking personality, and vastly more. Its memory is the encyclopædia memory of the subconscious. Apparently nothing once fixed is ever lost, although our knowledge along this line is still meager. The power of waking recollection diminishes with old age. It would be important to determine whether the same is true of (subconscious) memory, or whether, as seems probable from superficial observation, this continues unimpaired as long as the organism holds together. I do not know of any scientific studies of old age, from this standpoint.

The life of the mind is continuous. It is not distracted and interrupted, like the life of the waking person. It never sleeps, except possibly during a state of coma. In fact the mind is in some ways most active during what we call sleep.

The mind sometimes appears like an ungoverned flood of memories, images, thoughts, feelings. Sometimes a part of the current is divided into one or more personalities; memories, etc., are specialized for a distinct task; the stream flows through a channel of neurones and synapses as through a mill-race. But controlling both the flood and the mill-race, like a force of gravitation, appears an underlying unity. Thus the mind, even when unconscious, solves problems, forms images, acts parts. Whatever may appear in a given personality, for dramatic purposes, innumerable experiences have produced a unity of mental habit. Thus the devout Roman Catholic is kept from sacrilege, even in the hypnotic state, and the modest woman from sticking out her tongue or disrobing. In cases of divided personality there appears to be a deeper common stratum to which the mental healer is able to appeal. Beneath the old Mr. Hanna and the secondary Mr. Hanna was a mind which formed a common vehicle for suggestion. So with Mary Reynolds in her three characters. Most suggestive of all is Dr.

Janet's Léonore, emerging from the subconscious below the subconscious.

I referred a few pages back to the apparent identity of psychical and biological unity. Another evidence of this may now be given. Mind controls not only the muscles utilized by the waking personality, but also muscles governing blood-circulation, and hence metabolism. Even in our waking hours we have "involuntary" blushes, tears and sweat. In sleep, the cerebral hemispheres being comparatively at rest, the lower nerve-centers are more readily utilized. The body is remarkably subject to suggestion, a fact made use of by the mental healer. The recuperative value of sleep may be, as Myers suggests, in the increased attention which the mind is able to give to organic processes.

It seems safe to conclude that the mind accompanying and controlling the human organism is an individual for philosophy, as well as for law and for practical life. When does this individual begin its existence? If mind is what it appears to be, only a specialized form of life, a new mind would begin with the starting of a new organism on the union of ovum and spermatozoön. This is borne out by the fact that temperament and other mental traits are apt to be inherited from the parents. Prenatal memory is, in my opinion, not yet established as a scientific fact.* *A priori*, influence of the mother's mind on that of the babe is exceedingly probable, but we are not dealing with the *a priori*.

* *Cf.* discussion in J. Arthur Thomson, *Heredity*, 1908.

Cosmic memory does not seem to exist except for the poets.

If uterine conception is the probable terminus *a quo* of the mind, can we assign any terminus *ad quem?* The individual appears to break up at death, like the physical organism with which it has been associated. But there are a number of facts which warn us that this dissolution of mind may be merely apparent. The mind is not a physical machine; it is that which organizes and controls the machine. The mind is to a certain extent independent of the condition of the organism; it may be most active in invalids, during sleep, or when we are physically tired. Again mind lives and works after the conscious personality, because of some neurone disturbance or degeneration, has practically ceased to be. We see this in insanity and idiocy, where muscular control and other mental powers are often above the normal.

So-called spirit-possession and communication may be explained on other grounds. Second sight, although probable, has not yet been proved. But telepathy, which I consider already established, suggests a striking independence of the physical. Ideas, images and feelings may be transferred from one mind to another without making use of any known physical medium. Distance seems to make no difference. To use a rather dangerous analogy, telepathic communications appear like wireless messages, which may be detected by any one, even a stranger, who happens to be "in tune."

An accumulation of evidence shows that telepathic messages are most frequently sent when death is approaching or threatening. Gurney, in his *Phantasms of the Living,* describes one hundred and thirty-four cases where the hallucination occurred at the time of death, or within an hour. Thirty-eight occurred more than an hour before the death of the person seen, but during his serious illness, thirty-nine occurred after death but within less than twelve hours, while one hundred and four were closely associated with death, though it was not known whether they occurred before or after. Hallucinations involving longer intervals were not included. Known cases of apparition in crises are almost as numerous. The mind seems to be particularly active at the time of death. Altogether, I think there is a strong presumption that the mind survives the dissolution of the body, rather than the reverse. Presumptions, however, are not good building material for philosophy.

We are evidently getting near the end of our rope again. The same limitation confronts us as in biology. Induction fails, because the facts are incomplete. Mind is a certain side of the life of a higher organism taken as a whole; or, if you please, it is organic life observed from a new angle. What mind is in itself, apart from organism, and whether there is any mind not connected with a brain and nervous system, are questions for which we have as yet no solvent.

We know that there is mind in the universe. By mind, to analyze the concept, we mean the individual minds associated with organisms on this planet, and such other mind or minds as may exist under other conditions.

We know that, at a certain period in the history of the universe, mind became localized in terrestrial organisms. The minds of these organisms, acting upon and being acted on by their environment, came, through a vast series of mutations, to be represented by the human species. Man has not changed to any great extent during 400,000 years or more, and no higher organism is to be expected on the earth.* But although man represents a highly-perfected adjustment of mind to a physical environment, the subconscious field gives frequent suggestion of powers not realized by the organism in its waking state. Mind does not seem to have reached its full possibilities.

We know that the organism, and to some extent the outside physical world, is under the control of mind.

Does psychology teach us anything more? Mind, as we know it and are able to study it, always comes from some preëxisting mind. By analogy, there is mind back of the first appearance of life on this planet.

* The principal evidence for this statement may be thus summarized: 1. The anthropoidea represent a highly-specialized type; the generalized types from which new species would be likely to arise have disappeared. 2. The golden age of the anthropoidea, aside from man, is in the distant past. 3. Man now dominates organic evolution in all parts of the earth. 4. Man represents largely the specialization of the upper brain, and any further enlargement of this would cut off the nasal cavity from the throat. 5. Evidence has already been given that man cannot rise higher except through education, every child (with some allowance for selection and eugenics) starting at practically the same level.

Such non-organic, cosmic mind may be presumed to exist today, if it existed then. It may or may not resemble the mind which has developed in connection with organism. Communication is easily possible between such cosmic mind, if it exists, and the mind of man, as we see from telepathy, from personal influence, from hypnotic rapport. But what we lack, thus far in our enquiry, is the definite evidence of such communication. Proof of the existence, or the non-existence, of God is beyond the scope of psychology.

Is mind as such independent of space and time? Thus far we do not know mind as such, but telepathy suggests that, when we do, it will be found independent of space—that is of relations measured by means of light-rays. Mind is known to possess a remarkable power of measuring temporal sequences, but the machinery for this may be the physical organism, whose sequences are measurable.

CHAPTER XVI

THE HIGHER LIFE OF MAN

THE recent movement known as Pragmatism has called attention to the increasing richness of reality due to the coming of man. There was plenty of reality in the universe before that, which many careless Pragmatists seem to forget. The hills were full of minerals. The trees were covered with fruit, and birds sang in their branches. But with the coming of man the minerals and the fruit and the bird-calls acquired a new value. And that value—the judgment of value in men's minds—was as much a part of reality as the gold or the apples or the music. Man's mind, reacting to the physical world, added something that the physical world alone never would have possessed. The net result has been the continued development of the world of reality, as man took to mining gold and making ornaments of it, or to eating apples and cultivating new varieties, or to rivalling with his own voice the lark or the veery. Even if man became extinct, and no such mental life was ever known again, this planet would have added a wonderful closed chapter to the story of the universe—a tale of ideas about things, of the adaptation of things to definite ends, of the development in things of a complexity, a harmony, a utility, a beauty, elsewhere unknown on the same scale.

With the rise of man as a distinct species, human evolution became predominantly psychical. The differences between races and individuals are chiefly those of education, in the broad sense. We have seen that there is no real difference in educability between the savage and the civilized child. If taken young enough and placed in primitive surroundings, the civilized child would grow up a savage, with simple ideas and comparatively simple brain development. Conversely, the savage child would grow up to be a civilized man, with complex ideas, and with a somewhat more complex and probably larger brain.

The evolution of society therefore is not organic, except as its units have been human organisms. It consists rather of the accumulation of ideas in individual minds and in their transmission from one mind to another. It is the evolution of an environment that is fundamentally psychical. What we know as civilization is simply the accumulated experience of the race. The civilized child enters on a richer heritage of ideas, represented by spoken and written language, by books, by schools and apprenticeships, by buildings and arts and machines, by customs and institutions. A book or a machine would be of no value to the savage. It is of value to civilized man only as the ideas which have entered into its making again become ideas in some living mind. The simplest tool is a psychical even more than a physical product. It represents the mental experience of many generations of men.

Recent studies in historical sociology have been fruitful in proportion as they have recognized this truth and adopted the psychological rather than the biological method of approach. We are talking less about society as an organism—the only organisms are organisms—and more about the personal units which together make up the "social mind." Social causes and processes are still debatable ground and perhaps always will be. But many facts of social evolution are now fairly well established. We may first sketch the different stages through which human society is known to have passed.

(*a*) *The Horde.* Man, as we have seen, is naturally social—even more so than the other primates. The human species probably originated as a horde, or multiplicity of hordes, and this is the most primitive form of society today. Each horde "is composed of a few families, and comprises usually not more than from twenty-five to one hundred persons. No such horde is found living beyond the reach of communication with other similar hordes of the same race, language, and culture. Under the influence of excitement or fear, or to share an unusual food supply, or for the purpose of migration, such hordes may temporarily congregate in large numbers. But they do not permanently combine with one another under the leadership of a common chief for military or political action, nor is there any organization, religious or industrial for example, that binds them together in a larger whole."* The

* Giddings, *Principles of Sociology,* 157.

practical mental equipment common to the population of the horde includes: experience gained in testing various articles of food, adornment and perhaps dress and various means of shelter; simple ideas of utility, satisfaction, wealth and personal property; knowledge of how to make and use fire and some simple tools and weapons; the development of natural human speech into a definite language; ideas of common territory, of leadership and allegiance, of kinship; the ideas of self, of spirit, of friendly or unfriendly spirits present in the world.

(*b*) The second important stage (leaving out various stages which are transitional) is that represented by *the Metronymic Tribe.* This is a very much larger group, closely organized and occupying a definite territory. The change, however brought about, indicates an advance in food supply and probably the addition of agriculture, with considerable improvement in tools, weapons and arts. There are an expansion of language and a greater stock of traditions, stories and reflections. Relationship is reckoned only through the mother. The tribe is divided by kinship into clans, often named from some totem—usually an animal or plant—from which the clan is supposed to be descended and with which it cultivates relations. Marriage within the same clan would be regarded as incest. The husband lives with his wife's kindred. Each clan has its governing council with its peace sachem and war chief. All this implies definite ideas of justice, order and coöperation. The tribe, essentially a military unit, also has a council. There may be a third organization, the phratry, composed of several related clans, and having oversight of religious exercises and also of sports. Life is still on a communal basis and the individual is subordinated to the community. Metronymic tribes often unite in permanent military confederations, as in the case of the Iroquois.

(*c*) *The Patronymic Tribe* may arise from the metronymic tribe or directly from the horde. There is the same or greater economic advance than in the last stage. The patronymic tribe is usually connected with the domestication of animals and the increased economic value of women and children. The husband keeps one or more wives in his home. Relationship is reckoned through fathers, and the authority of the father becomes paramount. A supposed common ancestor takes the place of the plant or animal totem. The (paternal) clan is now practically identical with the village or the neighborhood community. The tribe is much more compact in its organization, with a head chief. Clan and tribal offices tend to become hereditary. Wealth is likely to become concentrated in a few families, which are thus able to keep slaves and retainers. Personal allegiance becomes stronger than kinship.

(*d*) *The Patronymic Confederation.* "Under the pressure of a common danger or inspired by a common ambition, patronymic tribes of the same racial stock, dwelling within a territory of geographical unity, unite in military confederations that are more coherent, more formidable, and more stable than the strongest of metronymic confederations. A patronymic confederation is a folk or people, and it may develop into a great civil state. The Egyptians, the Chaldeans, the Hebrews, the Greeks, the Romans, the Saxons, the Franks, the Germans, and the Slavs were tribally organized peoples, which, by subsequent growth and integration, developed into national states. Each of those peoples began its ethnical career in an environment of such extent and of such geographical unity as to make the growth of a single society of large numbers and of considerable dispersion easily possible, and of such varied productiveness as to stimulate desire, inventiveness, and activity. It cannot be supposed that the territory occupied by any of those peoples was populated by descendants of a single small horde. It is more probable that the ethnical unity was the result of an assimilation of many diverse tribal elements which, attracted by a superior environment, came together in the course of their wanderings."* The confederation once formed, there springs up the idea of a common ancestor for all the tribes. The chieftaincy becomes the kingship, and the organization of society is more or less feudal. The confederation usually enters on a career of migration or conquest, partly for the sake of plunder, partly to secure a subject population for agricultural labor.

The further development of the race during the historical period continues to be chiefly psychical. Prog-

* *Id.*, 296.

ress has been due to new ideas, or to greater accumulation of ideas from past experience. It has not been due to natural selection. Benjamin Kidd is certainly mistaken in his statement that "left to himself, this high-born creature, whose progress we seem to take for granted, has not the slightest innate tendency to make any onward progress whatever."* It would be more true to say that man being what he is, with the powers described in our chapter on the human mind, it was only a question of time when he would develop a culture like that of Southwestern Europe in the late Paleolithic Age, or that of Khamurabi's Empire, or that of Athens in the time of Pericles.

The first great civilizations probably developed in alluvial plains, such as those about the Nile, the Euphrates and the Yangtse. A large population could be supported in a small territory, permitting the development of public works, such as irrigation, of city centers, of manufactures and commerce. Some of the greatest advances in arts and institutions, however, were made by nations in less favored, often comparatively barren, localities, but still in contact with the river civilizations. For this the eastern Mediterranean region was peculiarly favorable, two continents joining in the neighborhood of Egypt and Babylonia, with a third continent not far away. These at first minor nations borrowed their culture and then improved on it. The most striking instances are the Ægean civilization (roughly 4000 to 1000 B.C., and possibly indigenous), the military or-

* *Social Evolution,* 1895, p. 36.

ganization developed by Assyria, the ethical culture of Israel, the work of the Phœnicians in manufactures, commerce, navigation and the use of the alphabet, the achievements of the Greeks in art and science, and the ideas of government—local and imperial—developed by Rome.

The history of civilization, until modern times, is a history of the repeated inundation of the civilized nations by barbarian hordes. The bulk of the population remained unchanged. In most cases the new ruling class assimilated the culture of the conquered and infused new life into the old institutions. The most important inundation was that which occurred on the breaking down of the Roman empire. The old culture was so completely buried, and the accumulated experience of centuries so far lost, that for a long period its recovery seemed doubtful. The crafts, architecture, literatures and political institutions of medieval Europe were largely new accumulations, though with a nucleus of the old. Something of Greek science and literature was transmitted by the Saracens. The Renascence marked the recovery of a large part of the buried accumulation. Among the new accessions to the common fund from this and the following period we may note the introduction of gunpowder into Europe early in the fourteenth century, the invention of printing about 1439, the discovery of the New World in 1492, the recovery by Copernicus, in 1543, of knowledge of the true position of the earth among the heavenly bodies, the discovery of the circulation of the blood by Harvey, published in 1628, and the practical utilization of steam by Watt in 1782.

The invention of the steam engine marks the beginning of the modern industrial era. The development during the last hundred and thirty years has been incomparably rapid. Along all lines, with the possible exception of law and some sides of architecture, art and letters, man has surpassed anything previously known in his cultural history. Science may almost be said to begin with the nineteenth century, and our knowledge is still increasing at an ever-accelerating rate. Scientific agriculture is constantly enabling man to produce more from the soil and support a constantly-increasing population. Steam transportation has unified commercially the various countries of the world and the world as a whole. The use of power machines and the growth of large factories has enriched and cheapened production. That modern civilization is an accumulation is seen from the fact that a semi-civilized nation like Japan has been able in a generation to adopt almost the entire culture gathered by modern Europe and America.

The achievements of man in the modern era are not due entirely to the introduction of steam. This invention itself, the contemporary of others and the forerunner of many more, must be traced, as Kidd has pointed out, to the democratic spirit introduced into the European environment by the Reformation, and originally by the teachings of Jesus. England undoubtedly took the lead in invention because opportunity was more general there than elsewhere. Arkwright, Watt and Stephenson, for instance, had a humble origin. One started life as a barber, another as apprentice to an instrument maker, and the third as a colliery fireman. But they had a freedom of initiative, a chance to develop their powers, an opportunity for advance in the industrial world, which would not have been possible to such men born three centuries earlier. Some pages of Mr. Kidd's book are well worth quoting in this connection. The legislative history of the nineteen years since the book was written shows a further extension of the movement he describes.

"Throughout the history of the Western peoples there is one central fact which underlies all the shifting scenes which move across the pages of the historian. The political history of the centuries so far may be summed up in a single sentence: it is the story of the political and the social enfranchisement of the masses of the people hitherto universally excluded from participation in the rivalry of existence on terms of equality. This change, it is seen, is being accomplished against the most prolonged and determined resistance at many points, and under innumerable forms, of the power-holding classes which obtained under an earlier constitution of society the influence which they have hitherto, to a large extent, although in gradually diminishing measure, continued to enjoy. The point at which the process tends to culminate is a condition of society in which the whole mass of the excluded people will be at last brought into the rivalry of existence on a footing of equality of opportunity.

"The steps in this process have been slow to a degree, but the development has never been interrupted, and it probably will not be until it has reached that point up to which it has always been the inherent tendency of the principle of our civilization to carry it. The first great stage in the advance was accomplished when slavery, for the first time in history, became extinct in Europe somewhere about the fourteenth century. From this point onward the development has continued under many forms amongst the peoples included in our civilization—locally accelerated or retarded by various causes, but always in progress. Amongst all the Western peoples there has been a slow but sure restriction of the absolute power possessed under military rule by the head of the state. The gradual decay of feudalism has been accompanied by the transfer of a large part of the rights, considerably modified, of the feudal lords to the landowning, and later to the capitalist classes which succeeded them. But we find these rights undergoing a continuous process of restriction, as the classes which inherited them have been compelled to extend political power in ever-increasing measure to those immediately below. As the rights and power of the upper classes have been gradually curtailed, the great slowly-formed middle class has, in its turn, found itself confronted with the same developmental tendency. Wider and wider the circle of political influence has gradually extended.

Whether the progress has been made irregularly amid the throes of revolution, or more regularly in the orderly course of continuous legislative enactment, it has never ceased. The nineteenth century alone has witnessed an enormous extension of political power to the masses amongst most of the advanced peoples included in our civilization. In England the list of measures, aiming either directly or indirectly at the emancipation and the raising of the lower classes of the people, that have been placed on the statute-book in the lifetime of even the present generation, is an imposing one, and it continues yearly to be added to."

"It has been noticed that in that state of society which flourished under the military empires, the extent to which progress could be made was strictly limited. In a social order comprising a series of hereditarily distinct groups or classes, and resting ultimately on a broad basis of slavery, the great majority of the people were penned off apart, and excluded from all opportunity of developing their own personalities. Those forces which have created the modern world could, therefore, have little opportunity for action or for development. In Eastern countries, where the institution of caste still prevails, we have, indeed, only an example of a condition of society in which (in the absence of that developmental force which we shall have to observe at work amongst ourselves) these groups and classes have become fixed and rigid, and in which, consequently, progress has been thwarted and impeded at every turn by innumerable barriers which have for ages prevented that free conflict of forces within the community which has made so powerfully for progress among the Western peoples.

"When we follow the process of development gradually proceeding throughout European history, we can be in no doubt as to its character. We see that the energies of men, instead of being, as in the earlier societies, either stifled altogether, or absorbed in the service of the state to be utilized largely in the exploitation of other peoples by violence, have continually tended to find a freer outlet. But the process, we observe, has been accompanied by a steady increase of energy, enterprise, and activity amongst the peoples most affected. As the movement which is bringing the excluded masses of the people into the competition of life on a footing of equality has continued, its tendency, while humanizing the conditions, has unmistakably been to develop in intensity, and to raise in efficiency the rivalry in which, as the first condition of progress, we are all engaged. As the opportunity has been more and more fully secured to the individual to follow without restraint of class, privilege, or birth wherever his capacity or abilities lead him, so also have all those features of vigorous enterprise, indomitable energy, and restless activity which distinguish the leading branches of the European peoples become more marked. As the rivalry has become freer and fairer, the stress has become greater and the results more striking. All those remarkable features of the modern world which impress the imagination, which serve to distinguish our times so effectively from the past, and which have to a large extent contributed to place the European peoples outside the fear of rivalry from any other section of the race are, in effect, but the result of those strenuous conditions of life which have accompanied the free play of forces in the community, this latter being in its turn the direct product of the movement which is bringing the masses of the people into the rivalry of existence on conditions of equality."*

When the history of modern democracy is written, its first chapter will be devoted to an exposition of the teachings and example of Jesus. It will show how he added to the common fund the idea of the worth of man as man, whatever his parentage, race, wealth or previous condition. We are here concerned with this idea in its social and ethical rather than its religious aspect. What does it involve? First, a faith in one's fellow men, irrespective of family or nationality. The Jew had the Golden Rule in his Scriptures, but it applied only to fellow Jews, or at best to the exile from another land who happened to be within his gates. It did not apply to the Babylonian, to the Edomite, to the Samaritan, to the Greek or to the Roman. Jesus' teachings did not necessarily break down nationality, but they broke down national limits to ethical obligation. They broke down similar limits imposed by ties of blood, caste or rank. Men could not even shut out their competitors or their enemies. So much negatively. Positively, the new democracy means a belief in

* *Social Evolution,* 150 *ff.*

the possibilities open to every man; however unpromising or base.

Jesus' idea involves, secondly, an affection for every man—love, "charity," sympathy—the readiness to admit him to an equality of consideration, and as far as possible of opportunity. Third, the generating of faith and of a "fund of altruistic feeling," through the actual practice of brotherhood and democracy. Probably no one ever believed in the Golden Rule until he began to practise it. Wherever the followers of Jesus have practised brotherhood, in the earliest Christian centuries for instance, and in the revival of the teachings of Jesus before and during the Reformation, we see the spirit of democracy and the attempt to apply it to human relations and institutions. Altruism is not, as Drummond would teach us, a biological fact, a higher development of the reproductive instinct. The civilized child is naturally no more altruistic than the Paleolithic child. Altruism, like all other social forces, is an addition to the psychical equipment of the men and women who make up communities and nations.

In this connection some reference should be made to the ethical accumulations of the race before the time of Jesus. The passage from the horde to the clan means the subordination of the individual's interests and passions to the common interests of the clan. Later there is a similar subordination to the chieftain or king. The community spirit is in all cases an ethical force as well as a social bond. To break the community standards brought punishment, to disregard them altogether meant ostracism or banishment, if not death. These standards are embodied in generations of judicial decisions and afterward in written law.

The earliest complete law-code which has come down to us is that of Khamurabi, from about 2350 B. C. It reflects the complex city civilization of the Babylonia of that day. To quote Dr. Johns' summary in the *Encyclopædia Britannica:* "Almost all trace of tribal custom has already disappeared from the law of the Code. It is state-law; alike self-help, blood-feud, marriage by capture, are absent; though family solidarity, district responsibility, ordeal, the *lex talionis,* are primitive features that remain. The king is a benevolent autocrat, easily accessible to all his subjects, both able and willing to protect the weak against the highest-placed oppressor. The royal power, however, can only pardon when private resentment is appeased. The judges are strictly supervised and appeal is allowed. The whole land is covered with feudal holdings, masters of the levy, police, etc. There is a regular postal system. The *pax Babylonica* is so assured that private individuals do not hesitate to ride in their carriage from Babylon to the coast of the Mediterranean. The position of women is free and dignified."* In all respects the Code of Khamurabi compares favorably with the Roman law of 2,500 years later, and its ethical standards are perhaps higher than those of Roman law before the influence of Christianity began to be felt. Babylonian and Roman law represent independent

* *Enc. Brit.,* III, 116 b.

ethical accumulations, and stand as monuments to the higher life of man. Similar accumulations were begun elsewhere.

The various Hebrew law-codes have been separated by modern scholars, whose work in this investigation is one of the best examples which we have of sound inductive reasoning based on comparative study. These codes repay careful examination, though the Deuteronomic and Priestly must be taken as more or less ideal. The familiar Hebrew decalogue, found in Deuteronomy and also in Exodus, probably comes in its present form from about 600 B. C. and reflects the teachings of Isaiah and other great ethical leaders. Its form is negative, and it is possible to interpret it according to the limited ethical horizon of the average Hebrew. Even so, the later Jews show not only a grasp of certain fundamental moralities, but an ethical passion and a subordination of the individual life to moral principles, to which we find no parallel elsewhere. Gautama, Socrates and the Roman stoics were noble teachers of ethics, but they had only a limited and brief following. The morality of the ancient Germans was overcolored by Roman writers, like that of the noble savage of Rousseau's day; their community standards were those of the prosperous patronymic tribe. The Jews of the time of Christ, no longer independent and more or less scattered, formed a community largely governed by moral ideals. Their real rulers were not the Roman officials but the interpreters and preachers of the law. That law might be narrowly interpreted, but it was zealously and scrupulously followed by the Jews in Palestine and throughout the Empire. And the general standard of life was high, both absolutely and relatively. Nowhere in the world of that day do we see, for example, a purer home life or a more careful training of children.

When we turn from the average Jew to the greatest of the Hebrew prophets and poets, we find many anticipations of the broader interpretation given to the law by Jesus: the idea of service to the world as well as to Israel, almost rising at times to the thought of the brotherhood of man; the duty of justice and consideration to the poor and oppressed; the subordination of ceremonial to conduct, of outward action to controlling motive, of letter to spirit, of material to moral values; even the emphasis (by Jeremiah, and still more by Ezekiel) on individual responsibility. Taken as a whole, Hebrew ethics must rank as one of the great achievements of the race, only equalled by the ethics practised by Jesus and his followers.

Perhaps the greatest achievements of the race have been in individual character. Our chief glory is the memory of such men as Moses, Hosea, Nehemiah, Gautama, Socrates, Jesus, Marcus Aurelius, Gregory the Great, Winfred Boniface, Saladin, Francis of Assisi, Wyclif, Coligny, Melancthon, Xavier, William Bradford, Colonel Hutchinson, Charles Wesley, Lafayette, Henry Havelock, Abraham Lincoln, David Livingstone, Mark Hopkins, Joseph Neesima, Father Damien; such women as Cornelia, Monica, Joan of

Arc, Santa Theresa, Renée of Ferrara, Madame Roland, Louise of Prussia, Elizabeth Fry, Mary Lyon, Queen Victoria, Mrs. Stowe, Florence Nightingale, Julia Ward Howe, Alice Freeman Palmer. The canon of human sainthood has wide limits. Greater than all our arts and inventions is the fact that multitudes of men and women are governing their lives by ideals of purity, of integrity, of justice, of neighborliness. To this ethical development animal life furnishes no parallel. Such facts must be given due consideration in a philosophy of the universe of which man forms a part.

CHAPTER XVII

THE SHADOWS OF HISTORY

WE have been considering the progress and achievements of man. What is there on the side away from the sun to which the pessimist would call our attention? In order to gain a fair estimate of the facts of human history and their value for philosophy, we must have all the facts. I have shown the high lights. To show history in its true perspective, I must paint a companion picture that will give the shadows.

There is, first of all, the argument from numbers. Carlyle's statement about so many million persons in the British isles, "mostly fools," may be extended outward and backward. The small proportion of the morally distinguished in the total population must tend to lower our estimate of the value of man as man.

Let us make a rough and arbitrary calculation of the total number of humans who have grown to maturity. Allowing 400,000 years for man's life on the earth, and three generations to each century, the following table of population is probably conservative.

Tripling these figures to allow for children who have never reached maturity, and doubling the total again to cover children conceived but not born, we should have the enormous total of three hundred and ninety-

PERIOD	YEARS	GENERATIONS	AVERAGE POPULATION	TOTAL
Paleolithic .	391,500	11,745	2,000,000	23,490,000,000
Neolithic .	3,500	105	50,000,000	5,250,000,000
Bronze Age .	2,000	60	100,000,000	6,000,000,000
Pre-Christ'n .	1,000	30	200,000,000	6,000,000,000
Christian to 1800 . .	1,800	54	400,000,000	21,600,000,000
1800-1860 .	60	2	700,000,000	1,400,000,000
1860-1890 .	30	1	1,000,000,000	1,000,000,000
Recent . .	34	1	1,500,000,000	1,500,000,000
				66,240,000,000

seven billion, four hundred and forty million human beings. Even if we confine our attention to the sixty-six billion mature persons accounted for in the table, it is doubtful if ten billion have had any culture worthy of the name. The remaining fifty-six billion have been savages, but little removed from the wild beasts with which they competed for food, or else slaves and coolies, morally degraded and economically dependent on a superior race. Of the ten billion "elect," how many would rank as anything more than ignorant, superstitious, irresponsible peasants? We seem to be thrown back on the survival theories of Darwin and his contemporaries. To produce a few thousand or million elect souls in each generation of the Christian era has cost the lives of vast multitudes through a period twenty times as long.

Civilization, far from being an unmixed blessing, has introduced conditions that are causing rapid physical degeneration. I quote at length from a paper by Dr. J. H. Kellogg of the Battle Creek Sanitarium before the Connecticut Conference of Charities and Correction in 1911.*

"For more than fifty years men whose studies or experiences have given them special opportunities for observation have been calling attention to the signs of degeneracy and the possibilities of the ultimate extinction of the human race unless preventive measures were adopted.

"A few years ago the English government created a commission charged with the duty of investigating the question of race degeneracy in England. This committee, known as the Inter-Departmental Committee on Physical Deterioration in Great Britain, made a very exhaustive study of the subject, taking the testimony of physicians, scientists, sociologists, magistrates, and people of all classes who had had opportunity for extensive and accurate observation, and published a voluminous report of their hearings. On page 177 of the report we read: 'In England, degeneration is especially manifest in Manchester and other manufacturing districts. The police force is largely recruited from country districts, it not being possible to find enough men who are large enough in Manchester and Salford.' A recruiting officer testified that 60 per cent of those who offered themselves as volunteers for military duty are rejected because of physical unfitness, and this notwithstanding the fact that the standard of requirements had been considerably lowered.

"Mr. Gray, a member of the Anthropological Insti-

* *Proceedings*, 1912, pp. 89 *ff.*

tute, noted a deterioration of physique in a portion of the population of Edinburgh and in the population of the west of Ireland. Within recent times attention has been drawn to the great number of defectives among school children. For instance, a Scotch committee which made an extensive study of this subject found 70 per cent of the children in the public schools of Scotland more or less abnormal. The condition in this country is no better. The New York Bureau of Municipal Research published the results of the examination of 1,500 school children in three city schools in which they found 93 per cent to be defective.

"We are rapidly becoming edentulous or toothless. The German authorities report that 90 per cent of the children of the public schools of that country have defective teeth. In Cambridge, England, a recent report of an examination of the public schools showed less than one per cent of the children eleven years of age or over whose teeth were sound. Professor Cunningham, the great English anatomist, has said: 'It is an obvious fact that the teeth of the people of the present time cannot stand comparison in point of durability with those of the earlier inhabitants of Britain. Those who have the opportunity of examining ancient skulls cannot fail to be struck with this.'

"Another evidence of deterioration is the diminishing birth-rate. The birth-rate in England has fallen from 35.3 per thousand in the five-year period 1876-1880, to 26.0 per thousand in 1906-1910. Each period of five years shows a material decrease from the preceding period. . . .

"The birth-rate is decreasing in nearly all civilized countries, as shown by the following table; the only exceptions being Spain, Austria and Ireland:

"DECREASE OF BIRTH-RATE BETWEEN 1880 AND 1902

"COUNTRIES SHOWING A DECREASED FERTILITY RATE

"Country	Decrease Per Cent.	Country	Decrease Per Cent.
"New South Wales	30.6	England and Wales	17.7
South Australia	28.0	Scotland	12.7
New Zealand	24.5	Denmark	9.8
Victoria	24.2	The Netherlands	9.5
Western Australia	23.9	German Empire	8.4
Queensland	23.2	Sweden	8.2
United States	20.0	Switzerland	6.4
Belgium	19.8	Norway	3.7
France	19.7	Italy	2.5

"The rates shown in the above tables are calculated on the number of married women between the ages of 15 and 45. It is a matter worthy of note that the birth-rate is diminishing more rapidly in the United States than in any other part of the world except Australia and New Zealand. The fertility of American wives is decreasing at the rate of one per cent a year. A recent census report shows the average number of children borne by native-born New England wives to be 2.7 and of foreign-born wives living in the same section 4.4.

"Another evidence of degeneracy of a kindred sort is the increasing inability of women to nurse their children. According to Dr. Holt, 'In New York at least three children out of every four born into the homes of the well-to-do classes must be fed at some other fount than the maternal breast.' Within the last few years an enormous business in the manufacture of infant foods has been built up in this country because of the inability of American mothers to nurse their infants, a fact which is in itself a most striking evidence of the progress which race degeneracy is making in this country. There is no doubt that in certain parts of the United States decay of the native population through diminished fertility is already far advanced, though the actual condition is for the present somewhat obscured by immigration and the large families of the newcomers.

"The increase of insanity and idiocy has become so marked in recent years that a note of alarm is frequently heard from alienists on both sides of the Atlantic. Dr. Forbes Winslow, one of the world's greatest authorities on mental diseases, recently stated in a public utterance published in the *London Times* that, in his opinion, the entire race is destined to become insane. The superintendent of the State Insane Asylum at Austin, Texas, in his last annual report called the attention of the people of that great state to the fact that insanity is increasing so rapidly in Texas that unless something is done to check it, it will not be many years before the insane will outnumber the sane, and, as the superintendent said, 'will break out of the asylums and put us in.'

"And other parts of the United States are far in advance of Texas in mental decadence. For example, in 1867 the proportion of the insane in New York and in New England was about 1 to 1,600 of the population. At the present time the proportion of insane in New York is 1 to 273 of the total population, or practically six times as many. In a pamphlet by Homer Folks and Everett Elwood, issued by the State Charities Aid Association of New York, it is stated that there are in the hospitals of New York alone 32,657 insane persons—more than double the number in 1890, an increase of 104 per cent in twenty years, while the population in the same state has increased only 52 per cent. This number, great as it is, by no means represents the entire number of insane or of mental defectives in the State of New York, since the statistics of the hospitals show that about 25 per cent of all persons who are committed to the insane hospitals are discharged within a year as cured, at least temporarily, and 25 per cent more are discharged not cured, but improved sufficiently to be thought not to require asylum restraint. . . .

"Besides this great army of lunatics, there is an equally large army of idiots and weak-minded persons, constituting a group of defectives which reaches not less than 300,000. Professor Davenport, head of the Department of Eugenics of the Carnegie Institute, recently informed me that a study of defectives in the State of New Jersey shows that the feeble-minded class has doubled in that State in a single generation. The proportion is now 1 to 250 of the total population. In Ireland, an older country, the proportion is 1 to 147. Evidently there are lower levels of mental degeneracy which we have not yet reached, and toward which we are hastening. We now have one mental defective (insane or feeble-minded) in every 150 of our population. Ireland has 1 to 77 insane or feeble-minded. These terrible facts demand attention. We are creating a lunatic and idiot population which threatens to become a majority within a few short centuries.

"Another degenerative malady characteristic of civilization is cancer. Williams has shown that this disease is practically unknown among the wild races of men and of animals; that it is found most common in the most highly civilized communities and among domestic animals. Cancer at the present time kills one in twenty of all the people dying in the United States. Its prevalence has increased 500 per cent in sixty years. Cancer is a chronic disease, and the death of 75,000 from this disease in the United States annually in spite of the best efforts of modern surgery means that not less than 300,000 are suffering constantly from this most loathsome malady. At the present rate of increase, by the middle of the century at least 1 in 40 of the entire population will be suffering from this disease, and 25 per cent of the mortality will be due to it. . . .

"Chronic diseases and degenerations of all sorts are increasing, and at a very rapid rate in recent times. Careful study of the mortality reports of the United

States Census Bureau makes this fact very clear. . . . The mortality from diabetes, in spite of all the discoveries in metabolism and improvements in dietetics, has increased nearly 50 per cent in ten years; and the mortality from appendicitis, notwithstanding the best efforts of able surgeons, has increased more than 20 per cent in the same time. During the same time, the mortality from heart disease has increased over 50 per cent. Mr. Rittenhouse, late president of the Provident Savings Life Assurance Society of New York, has recently called attention to the fact that there has been an increase in the mortality from Bright's disease throughout the United States of 131 per cent.

"Chronic disease kills half the people who die in the United States, or about 750,000 persons annually. Half of these, that is 375,000, would not die if the average health were as good as thirty years ago. This enormous increase in the mortality rate from chronic disease has escaped the attention of sanitarians because of the notable decrease in the general death rate, as the result of a decrease in deaths from acute disease so great as to more than equal the increase in deaths from chronic disease. . . .

"When we turn from the contemplation of physical disorders to the consideration of moral maladies, the picture is darker still. Crime is increasing at a rapid rate. There are 10,000 murders and 16,000 suicides every year,—one murder in every 9,000 of the population annually, and one suicide in every 5,800.

"In France, according to the *Revue de Paris,* crime is increasing rapidly, especially juvenile crime. There are 400,000 highway robberies in France annually. A criminal type of men and women is developing, and has already reached large proportions in all civilized countries. A bulletin recently sent out by the Eugenics Record Office of the Carnegie Institution tells of a family with 319 members, only 42 of whom were normal; and the proportions, we are informed, have since been increased to 600, with only 50 normal.

"Another evidence of the one-sided hygiene which simply preserves the unfit while doing nothing to cure their unfitness appears in the marked depreciation in the proportion of centenarians to the whole population which is going on in all civilized countries. The real measure of the physical vigor of a race is not the age at which the average man dies, but the proportion of individuals who attain to great age. Cholera, yellow fever epidemics, and other plagues in former times weeded out the weaklings, drunkards, debauchees and other classes of the unfit. By keeping these alive through quarantine and public sanitation, the average longevity is increased, while both the actual number as well as the proportion of centenarians has been steadily diminishing.

"Senility and youth are approaching each other, and the time seems not far distant when the normal interval between youth and second childhood will disappear, and childhood will be met by second childhood. A Philadelphia doctor reported a youth of 28 years whose arteries were as hard as pipe stems, and a German authority reported a similar case in which the patient's age was 17 years. Men and women of 40 who present all the evidences of advanced senility are rapidly increasing in number. The responsible cause is the same as that which produces the increasing mortality from Bright's disease, heart disease, and pneumonia. Degenerated kidneys, hardened arteries, fatty heart are simply old kidneys and arteries, and senile heart."

Passing to economics, let us glance at some of the conditions found in the United States, the most favored country of its size in the world. The continental population in 1910 was 91,972,266. In the previous year 6,615,046 were classed as wage-earners in manufacturing industries, the distinctive economic product of civilization. Of these workers the average weekly wage for men was $11.16; for women $6.17; for children under 16, $3.46. Some concrete examples will make these figures live.

In February, 1910, a strike at Bethlehem, Pennsylvania, called attention to labor conditions in that region. Of the 9,184 men employed by the steel plant, 4,725 were found to have a twelve-hour work day, and those on slightly shorter schedules were frequently required to work overtime. When shifts were changed, twenty-four consecutive hours was not uncommon. Twenty-eight per cent of all employees worked regularly seven days in the week, and others irregularly, bringing the percentage up to forty-three. Sixty-one per cent earned less than eighteen cents an hour, and

31.9 per cent less than fourteen cents an hour, or under $1.68 for a twelve-hour working day. Large numbers were working for 12 1/2 cents an hour, twelve hours a day, seven days a week.*

The Survey made of the Pittsburgh district in 1907 by the Russell Sage Foundation revealed similar conditions. Of the 70,000 mill workers in the county, at least one in every five worked seven days a week. The twelve-hour day had come to be the standard for the majority. Every second week, sixty per cent of the blast-furnace workers had their "long turn" of twenty-four hours. "Home," said many a man to the Survey workers, "is just the place where I eat and sleep. I live in the mills." In the budget of the Slav families, the food cost was found to be about twenty-five cents a day a man. While the cost of living had gone up twenty-two per cent in the seventeen years since the crushing of the unions in the Homestead Strike, the Steel Corporation was paying only eleven per cent more than in 1892 (an average of 16 1/2 cents as compared with fourteen) and this at a time of unexampled prosperity in the steel industry, following "a period of marvellous industrial concentration and mechanical advance." In the Jones and Laughlin mills, the largest independent plant in Pittsburgh, the rate for day labor was fifteen cents per hour, an advance of only seven per cent. Skilled workers had suffered a very much greater reduction in their earning power.

* *Special Report of U. S. Bureau of Labor,* May, 1910.

Many of the mills would not engage laborers over forty years of age, and in some departments men over thirty-five were not employed. The industry not only demanded fresh supplies of men in their prime, but the workers were speeded up to the limit of their capacity. The pay was in many cases determined by the piece-work put through by a crew of men. A bonus was given the foreman for increased production. To this speeding up and consequent over-exertion is undoubtedly due the fact that at least 2,000 men are hired each year for every 1,000 positions. The human tide flows from Europe and back again with each rise and fall in the steel industry. Rebellion among the workmen was kept quiet by the rather illusive stock-sharing offer, by a regular system of espionage, and by the discharging of all men who attempted to form labor unions.*

With his long hours of exhausting toil, in constant danger, with little insurance against disability and none at all against non-employment, exploited by grasping landlords and by the saloon-keepers of the neighborhood (in McKeesport alone, a borough of 30,000 people, the ninety saloons took in $60,000 after every pay day), compelled to live in crowded and often squalid quarters under the most unsanitary conditions, too ignorant or too cowed and weary to make any effort for industrial or civil betterment—what chance has a man for the cultivation of the higher life, even in the pres-

* Report of the Pittsburgh Survey: *Homestead,* 1910; *The Steel Workers,* 1911; art. by John R. Commons, *Charities,* XXI, 1051 (1909).

ence of trade-schools and museums and Carnegie libraries? Yet this is civilization!

Of the working women in Pittsburgh—and they are probably typical of the 1,290,253 women wage-earners in the entire country—less than a fifth were earning $8 or over, and three-fifths were earning less than $7 a week, although working ten and twelve hours a day, and often much longer in the rush seasons. They generally began at fifty cents a day. Some firms never paid their adult women more than $4 a week. A living budget might possibly be made up on $7 a week, with no allowance for amusements or extras.* Recent studies have placed the standard at $8 or $9 for wholesome and pure living among working girls. Economic pressure has been one cause, though by no means the only cause, of the alarming spread of prostitution, which in Chicago alone was shown by the Vice Commission to claim 100,000 women, or one out of every five hundred, probably 5,000 girls being sacrificed every year to the traffic. Yet this is civilization!

In discussing child labor—there were 162,000 wage-earners under sixteen in the manufacturing industries of the United States in 1909—I again take a case from Pittsburgh. A boy was employed in a toby factory, rolling cheap cigars. He was twelve years old, and at the time of the investigation had already been at work seven months. His hours were six A. M. to eight P. M., with intermissions of fifteen minutes for lunch and twenty minutes for supper—thirty-five minutes in four-

* *Charities,* XXI, 1118 *ff.*

teen hours. He did not work Saturdays till evening, when he was on duty from seven until midnight and sometimes after. Worked regularly on Sundays. The room in which he rolled his tobies was dark and poorly ventilated, the air charged with tobacco dust. The boy seemed gentle and uncomplaining, but coughed a good deal and spoke of pains in his back and chest.* Yet this is civilization!

When Robert W. de Forest took hold of the tenement-house problem in New York in 1903, he found "conditions in many instances to be so bad that the most sensational newspapers of the city would hesitate to publish photographs of them. Vile privies and privy sinks; foul cellars full of rubbish, in many cases of garbage and decomposing fecal matter; dilapidated and dangerous stairs; plumbing pipes containing large holes emitting sewer gas through the houses; rooms so dark that one cannot see the people in them; cellars occupied as sleeping places; dangerous bakeries, without proper protection in case of fire; pigs, goats, horses, and other animals kept in cellars; dangerous old fire-traps without fire-escapes; disease-breeding rags and junk stored in tenement-houses; halls kept dark at night, endangering the lives and safety of the occupants; buildings without adequate water supply."† Under such conditions human beings lived and worked and increased their kind. One family to a room was a common occurrence, and the single room often included

* *Nat. Child Labor Com.*, Pamphlet 11, 1905.

† Report to Board of Estimate, *Charities*, XI, 355 (1903).

boarders. Privacy was impossible, or even decency. Grown girls stripped to the waist would go to the common sink to wash. Often the tenement harbored a public prostitute. Similar housing conditions have been found in practically all the great industrial cities of America, as the searchlight has been turned upon them one by one. Yet this is civilization!

With the increase of poverty, involving ten million persons according to Robert Hunter's estimate a few years ago, has gone the increasing concentration of wealth. The total wealth of the United States in 1904 was estimated by the Census Bureau at $107,104,211,-917. Almost all of this (ninety-four per cent) has been accumulated since 1840, and we are now, says Josiah Strong, increasing it at the rate of $8,000,000 a day. How is this enormous wealth distributed? The figures of G. K. Holmes for the tenth census showed that .03 per cent of the people owned twenty per cent of the wealth; that 8.97 per cent of the people owned fifty-one per cent of the wealth; and that ninety-one per cent of the people owned only twenty-nine per cent of the wealth. The testimony given before the Pujo Committee, in December, 1912, showed that, by a system of interlocking directorates, a group of twenty-five or thirty great financiers have at their command twenty-five billion dollars of capital, or practically a quarter of the entire wealth of the nation.

The Census Bureau has made the following estimates for the manufacturing industries of the country in 1909:

Capital	$18,428,270,000
Salaries	938,575,000
Wages	3,427,038,000
Cost of materials . . .	12,141,791,000
Value of product . . .	20,672,052,000
Added by manufacture . .	8,530,691,000

In other words, the increase in the value of the finished product, after deducting labor and cost of materials, was $4,165,078,000, or enough to pay over twenty-two per cent on the total capital invested, giving a very large margin of profit, even after due allowance for upkeep and depreciation had been made. The Standard Oil Company in 1911 paid $37 per share; in 1901 the dividend was as high as $48. The immense profits of the Steel Trust and many other large corporations have been disguised by skillful stock-watering. Is it any wonder that the working classes in this country are complaining that they are not receiving a proper proportion of the value which they produce?

"The fond owner of a diminutive black-and-tan dog gave a banquet in honor of the animal. The dog was worth, perhaps, fifty dollars. The festivities were very gay. The man's friends came to his dinner in droves, the men in evening clothes and the women bedecked in shimmering silks and flashing jewels. In the midst of the dinner, the man formally decorated his dog with a diamond collar worth fifteen thousand dollars. It contained seven hundred brilliants, varying in weight from one-sixth to one carat. The guests shouted their approval, and the dinner was regarded as a huge success."

"At a dinner party given by a notorious millionaire, each guest discovered in one of his oysters a magnificent black pearl. It was a fitting prelude to a sumptuous banquet and it contained an element of surprise. It was said that the dinner cost the giver twenty thousand dollars." Slav workers were probably toiling for him on a food budget of twenty-five cents per day per man.

"Very young and very wealthy was the young man whose attentions to an embryonic actress amused a community a few years back. It was the young man's opinion that he was desperately in love with the lady, who in later years married a publisher of songs. The millionaire youngster showered the girl with gifts. He gave her rings, bracelets, necklaces, and diamond-studded combs for her black tresses until she glistened from head to foot. The very buttons of her gloves were diamonds, and her shoes were fastened with monster pearls. The question of taste never entered into the situation. It was simply the spending of money and the bedecking of a coarse, but crafty, stage girl. In three years she succeeded in throwing away almost a million dollars for the deluded youngster, at the end of which time they parted."* Yet this is civilization!

What of the future? With the exploitation of the many by the few, resulting on the one hand in poverty and its accompanying moral and physical degeneration,

* F. T. Martin, *Passing of the Idle Rich,* 1911, pp. 32 *ff.*

and on the other hand in extravagance and luxury leading no less surely to degeneration, with the working classes organizing, in such bodies as The Industrial Workers of the World, not merely for better economic conditions, but for the actual conquest of the capitalist and the distribution of the spoils, with the bomb and the stiletto threatening to usher in a new French Revolution, the stock of civilization is decidedly below par. The "higher life of man" could be insured only as a war risk. Meanwhile the elect few play merrily on, above the volcano.

Here pessimism rests its case. To whom will the impartial student of social conditions give the verdict?

There is unquestionably a dark as well as a bright side to human history. To see the one without the other is wilful blindness.

The higher life of man—his capacity for improvement in every age from the first dawn of history, his human affections and sympathies even under the most debasing conditions of poverty or luxury, the intellectual and moral advance of a large proportion of the race —all this is a reality, even if civilization should fall in some new social cataclysm and the path of future progress be blocked for centuries by its ruins.

But such a climax is by no means certain. Black as is the picture which I have been compelled to draw, a closer study of the present situation reveals many encouraging features. The economic development of the civilized nations, through the introduction of power machinery and the organization of the factory system, has taken place with such rapidity that civilization has been unable to keep pace with the radical social and economic changes resulting. Pittsburgh, for instance, had grown in a comparatively few years from a group of country villages to a city of over half a million people. The several independent boroughs had not yet been incorporated into a single government. Sanitation had not received proper attention. Increased housing accommodations had been provided by private speculation, without public supervision or a due regard to the well-being of the people as a whole. That such a situation may be met successfully is shown by the changes already brought about in Pittsburgh since the Survey. The same is true of New York, where some of the worst evils have been remedied through the work of The Tenement House Commission. German industrial cities show an almost perfect adjustment to the new conditions. Modern medical science, backed by public opinion and the funds put at its disposal through government grants and private philanthropy, is attacking in earnest the problems of disease and degeneracy.

Much the same may be said of our economic system. The present is a period of transition, of uncompleted adjustment. Modern civilization is beginning to grapple with the problem of poverty itself. The democratic movement, which is becoming dominant in practically every modern country, has the purpose and apparently the power to bring about a better distribution of wealth, the securing by the workman of a fairer share in the value created by his labor, the shortening of hours, the improvement of factory conditions, and insurance against disability, non-employment and old age. To any one in touch with such a movement the future appears bright rather than dark.

That the millennium is at hand no one may claim. There are problems before us which will need for their solution the best leadership democracy can produce. Much that the old régime has contributed may be lost. Much that the new order expects will doubtless prove illusive. But that the present failures of civilization will largely be retrieved, there is ground for hope. Man seems likely to become a factor of ever-increasing weight in the scale of the universe.

PART IV

THE SPIRITUAL

CHAPTER XVIII

THE SOCIAL STAGES OF RELIGION

IT remains for us to consider a fourth group of phenomena, which may or may not be supernatural to psychology—the religious or "spiritual." Our first task is to examine impartially the facts gathered by comparative religion. This youthful science has suffered from the lack of any really adequate system of classification. The system which naturally suggests itself is the one used by historical sociology, for we find that, to a large extent, religious ideas run parallel to and are colored by the type of social organization. Professor Giddings has at least suggested this method. Robertson Smith and Frazer grasped some ends of it. But most of the men who have devoted themselves to comparative religion, such as the great teachers in Holland and France, were trained as theologians rather than as sociologists and so missed it entirely.

Let me illustrate this sociological classification of religion by typical examples. The many transitional stages are omitted for lack of space. It should be remembered also that all classifications in the field of sociology must be general rather than precise. Cultural ideas overlap the various social or economic stages. The institution of totemism, for example, is found among the low hunting peoples of Australia, the more developed hunting tribes of North America, the agricultural Polynesians and Pueblos, among pastoral tribes of central Africa, and even among some commercial and industrial peoples of India.* Religious ideas often overlap in the same way. The connection of religion and society is so close however that, on studying a new tribe, if we know the stage of society we can predict with considerable accuracy the stage of religion, and *vice versa.*

(*a*) *The primitive stage,* a term used merely as a comparative to cover various known types of organization and culture, ranging from the horde to the somewhat developed social organization of the American Indians. Whether religion is present throughout this stage depends on our definition of religion, but we find a circle of ideas which are closely connected with religion in its higher stages. The dominant fact is "animism," or the tendency of savages everywhere to personify all natural objects and to people the world with spirits, resembling themselves but often considered as more powerful.

Our first example will be taken from the tribes of North Central Australia, as described by Spencer and Gillen. These peoples, living in barren, inaccessible hills, have been isolated from external influences and preserve their native ideas and customs up to the present time. They are divided into tribal groups of totem clans and sub-clans. They have no agriculture

* J. G. Frazer, *Totemism and Exogamy,* 1910, Vol. IV, p. 18.

or domestication of animals, no clothing and no permanent abodes, no word for any number beyond three. Altogether these Central Australian tribes are perhaps on the lowest plane of culture hitherto known to us. Spencer and Gillen were especially fitted for the study of these people along scientific lines. As to religion or near-religion we may quote as follows:*

"In the first place, all the tribes believe in the former existence of individuals from whom, in some way or another, the living members of the tribes are descended. . . . All of them possessed powers superior to those of the present members of the tribe; but in no case, so far as we could ascertain, is there the slightest indication or trace of anything which could be described as ancestor worship. The simple fact is that these Alcheringa ancestors are constantly undergoing reincarnation, so that this belief, which is common to all of these tribes, practically precludes the development of anything like ancestor worship. Each of the more important amongst these [totemic] ancestors had certain ceremonies associated with him or her, but the performance of these, which takes place from time to time, is in no way a form of appeal to the individual in question, whom they do not regard (except in one particular instance in one tribe) as being desirous, or even, as far as we could ascertain, able, to help or to injure them, except in the most general way."

The one exception occurs among the Warramunga

* *The Northern Tribes of Central Australia,* 1904, pp. 494-501.

tribe in the case of the Wollunqua totem, "a huge snake, still existing at a spot in the Murchison range, and capable, if it feels so disposed, of coming out and injuring or even destroying the natives. It has actually, according to tradition, been known to do so, and there can be no doubt but that the series of ceremonies connected with it are, at least in part, performed with the vague idea of pleasing and propitiating it. While they have a certain amount of fear of the Wollunqua, yet at the same time the men of the totem group believe that they are able to control the snake, at least to a certain extent."

"In the Arunta tribe we meet with mischievous spirits called Oruntja, who are supposed to wander about more especially at night-time. There are certain spots, such as a hill close by Alice Springs, near to which no native cares to venture after dark, lest the Oruntja who dwells there should carry him off underground. . . . These Oruntja are regarded, however, as being mischievous rather than absolutely bad, and no attempt is made to propitiate them in any way whatever. During ceremonies concerned with them and representing their antics, the natives always evince a good deal of merriment, though at the same time they take good care to avoid the spots where they lurk.

"Perhaps, however, the most important spirit individual in the Arunta tribe is Twanyirika, whose voice is supposed by the women and children to be heard when the bull-roarer sounds. The Arunta have, so far as we could find out, no tradition dealing with the origin of [these sacred stones or slabs known as] the Churinga; their Alcheringa ancestors possessed them, and behind the Alcheringa they do not penetrate. The women and children are told that Twanyirika is a spirit who lives in wild and inaccessible regions, and only comes out when a boy is initiated. During the actual operation of circumcision, the bull-roarer sounds in the darkness all around the ceremonial ground, and the women believe that Twanyirika enters the body of the boy and takes him out into the bush, keeping him there until he has recovered. While he is there, carefully secluded from the sight of the women and children, he constantly sounds the bull-roarer. As soon as the operation is over the elder brother of the youth comes up to him with a bundle of Churinga, saying: 'Here is Twanyirika, of whom you have heard so much, they are Churinga and will help to heal you quickly; guard them well or else your (blood and tribal mothers and sisters) will be killed; do not let them go out of your sight, do not let your (blood and tribal mothers and sisters) see them; obey your elder brother, who will go with you; do not eat forbidden food.'

"In the Urabunna tribe the sacred stick given to the boy is called Chimbaliri. The women and children never hear this word, but are taught to believe that the sound is the voice of a spirit called Witurna, who takes the boy away, cuts out all of his insides, provides him with a new set, and brings him back an initiated youth." Similar spirits are found in other tribes.

"It was only on the coast of the Gulf of Carpentaria that we met with tribes amongst whom there was present the idea of spirit beings who could help or injure them. The Binbinga believe that the sky is inhabited by two spirits called Mundagadji, who are ill disposed toward the natives. Their bodies are covered with fine white down, and instead of arms they have knives. They are always anxious to come down and kill and eat some black fellow, but are constantly prevented from doing so by a friendly spirit called Ulurkura, who lives in the woods and watches for the coming of the Mundagadji and stops them. When a man dies the Mundagadji can always be heard singing up in the sky, and all three spirits can be seen by the medicine men."

This belief in spirits persists in higher stages, or people in higher stages tend to revert to this general habit of mind. I take as our second illustration the North American Indians, who in organization and general culture are far in advance of the peoples just mentioned. In their economic development they are still in the hunting stage, with some cultivation of the easily-grown Indian corn, but they have a full organization of clans and tribes and even confederacies.

Among the many Indian tribes I select the Dakotas (Sioux) of Southern Minnesota. We have here for the first time in our survey what may properly be described as worship. An early missionary, Rev. Gideon H. Pond, says that the quintessence of the Dakota religion consists in the word *wakan*. This word "signifies anything which is incomprehensible. The more incomprehensible the more wakan. The word is applied to anything, and everything, that is strange or mysterious. The general name for the gods in their dialect is this, Taku Wakan, i. e., that which is wakan. Whatever, therefore, is above the comprehension of a Dakota is God. Constantly, he sees gods everywhere. . . . *Wakan* is the one idea of divine essence. The chief, if not the only difference that they recognize to exist, among all the tens of thousands of their divinities, is the unessential one of a difference in the degree of their wakan qualities, or in the purposes for which they are wakan." The term is applied to the medicine man, and to the medicine feast and dance. There is no distinction between the classes of good and evil spirits; they are all simply wakan. "The Dakotas have another word to represent spirit, or soul, or ghost, but the word wakan is never used in that sense, though a spirit might be wakan. Evidence is also wanting to show that the Dakotas embraced in their religious tenets the idea of one Supreme Existence, whose existence is expressed by the term Great Spirit; this idea was probably borrowed from the whites." The idea of a Creator figures frequently in Indian mythology, but not strictly in Indian religion.*

The Dakota gods are always male and female, and propagate as do men and animals. Thus the Onktehi are a family of giants, resembling oxen, and are considered the special patrons of the medicine dance. "The

* Article on *Dakota Superstitions*, 1866, published in *Minnesota Hist. Soc. Collections*, Vol. II, p. 215.

dwelling place of the male is in the water, and the spirit of the female animates the earth. Hence, when the Dakota seems to be praying, chanting or offering sacrifices to the water or to the earth, it is to this family of the gods that the worship is rendered. They address the male as grandfather, and the female as grandmother. Hence, also, it is probable, that the bubbling springs of water are called the 'breathing places of the wakan.' "* The medicine sack owned by the initiated is the abode of a wakan which receives a great deal of the Dakota's worship.

Among the Dakotas, as among the Australians, spirit worship shades off on the one side into myth-making, or primitive philosophy, and on the other into magic, which might be described as primitive medicine, though it has to do with very much more than disease. Religion and magic are grounded in the same general ideas about spirits, and the distinction between them is not always easy to draw. The Dakota "medicine-lodge" appears to have been of late origin, a sort of imported free masonry. The medicine man has become practically a village priest, and the lodge ceremonies, open to both men and women, form the germ, as it were, of a community worship. To a certain extent, however, magic is always a private matter, about which the individual consults the fetish man much as we today consult a private practitioner. There is often, especially in later stages, a certain opposition between the religious leaders of the community and the dealer in magic.

* *Id.*, 219.

Apart from the rites of the medicine-lodge, the worship of the Dakotas consists largely in offerings, to express thanks or supplication. In the hunt, certain portions of the animal killed will be considered *Wohduze* to a god, or "taboo." Each young man, as part of the ceremony of becoming of age, selects a patron animal, which is thereafter *Wohduze* and must not be killed by him. There are also traces of clan "totems" among the Dakotas. Sacrifice enters into the sacred feasts, like that of the first-fruits. Some of the Dakotas will not partake of any food without offering a portion to the gods. Prayer is a frequent form of worship. *Tunkan,* for instance, is a very old god who inhabits rocks and stones and is considered the principal god of war. Usually a round stone, about the size of a man's head, is used for worship. The devout Dakota paints this red, perhaps putting colored swan's down on it, and then falls down and worships the god supposed to dwell in or near the stone. Another form of worship, especially among the western Sioux, is *Hanmdepi,* seeking a dream of revelation from the sun or other god. The necessary ecstasy is reached by self-mutilation, fasting and wild dances.*

As Lynd says, "there are no set seasons or times of worship. Each Dakota prays to his gods or makes sacrifices to them at such times and in such places as he deems best. In most cases, circumstances call forth his active religion, which otherwise lies dormant. Dreams

* James W. Lynd, *Religion of the Dakotas. Op. cit.,* 150 *ff.*

are a main source. A brave dreams repeatedly or vividly of the sun, and straightway he conceives it to be his duty to worship that luminary by a Sun Dance. Death makes its appearance in a family, and immediately the Dakota must propitiate the spirits of darkness by fasting and sacrifice. The wants of the Indian, also, are a prime source of his active religion. One wishes to be successful in stealing horses or upon the war path, and falls to begging the assistance of the deities by self-sacrifice, preceded by fasting, penance, and purification."*

(*b*) The democratic *clan organization,* usually metronymic, where, from a higher culture or some other cause, religious belief and practice has been definitely modified. The important fact to note is that religion is no longer a purely individual matter, as among the Dakotas, but an affair of the whole clan or village.

We may take as our chief example the Samoan Islands, where the clan god is thought of in the form of an animal or a plant or some other natural object. This may be due to the influence of totemism, or it may be due to the habit of personifying natural objects out of which totemism has grown. Totemism is not so universal or so influential as it was believed to be a decade or more ago. And Mr. Frazer is undoubtedly correct when he says, in his latest work, that totemism as such is not a religion and that it only becomes a religion on the break-up of totemism.†

* *Id.,* 170.

† *Totemism and Exogamy,* IV, 5.

The Samoan Islanders are divided into villages, each composed of perhaps ten to twenty families and from three hundred to five hundred people. We may call these villages *clans,* though the distinction is no longer of any special value. There is a village chief, the office usually being hereditary in one of the families. The heads of families—elected, not hereditary—constitute a governing council. A number of villages are united into a district, with a nominal king and a parliament composed of all the heads of families of the different villages. The spirit throughout is extremely democratic, even communistic. Each family group lives together in one or more large houses.

As among the Dakotas, each Samoan at birth "was supposed to be taken under the care of some god, or *aitu,* as it was called. The help of several of these gods was probably invoked in succession on the occasion, and the one who happened to be addressed just as the child was born was fixed on as the child's god for life." This god had some visible incarnation, which the individual honored and protected. "One, for instance, saw his god in the eel, another in the shark," etc. "A man would eat freely of what was regarded as the incarnation of the god of another man, but the incarnation of his own particular god he would consider it death to injure or to eat."*

Gods of the household or family group are also found in Samoa (compare under *c* below). It is not easy to determine whether these have arisen as develop-

* Geo. Turner, *Samoa a Hundred Years Ago,* 1884, p. 17.

ments of the individual guardian spirits, as survivals of original clan gods, or as new creations on the rise of the patronymic family. I merely give one suggestive example; all the Samoan gods are run in the same mould of thought. "O le Auma, *the red liver.* This family god was seen, or incarnate, in the wild pigeon. If any visitor happened to roast a pigeon while staying there, some member of the household would pay the penalty by being done up in leaves, as if ready to be baked, and carried and laid in the *cool* oven for a time, as an offering to show their unabated regard to Auma."

Our special interest in Samoa is in the village worship. "Every village," says Turner, "had its god, and everyone born in that village was regarded as the property of that god. I have got a child for so-and-so, a woman would say on the birth of her child, and name the village god. There was a small house or temple also consecrated to the deity of the place. Where there was no formal temple, the great house of the village, where the chiefs were in the habit of assembling, was the temple for the time being, as occasion required. Some settlements had a sacred grove as well as a temple, where prayers and offerings were presented."* The priesthood was hereditary in certain families. The priest "fixed the days for the annual feasts in honor of the deity, received the offerings, and thanked the people for them. He decided also whether or not the people might go to war."

As illustrations of these village gods we must con-

* *Id.*, 18.

tent ourselves with the following examples from Turner's list: "Fanonga, *Destruction.* This was the name of a war-god, and supposed to be incarnate in the Samoan owl. In time of war, offerings of food were presented to a pet one which was kept for the purpose. If it flew about above while the troops were walking along below that was a good omen; but if it flew away in the direction of the enemy it was supposed to have left the one party and gone to join the other, and therefore a calamity. At the beginning of the annual fish festivals, the chiefs and people of the village assembled round the opening of the first oven, and gave the first fish to the god. A dead owl found under a tree in the settlement was the signal for all the village to assemble at the place, burn their bodies with firebrands, and beat their foreheads with stones till the blood flowed, and so they expressed their sympathy and condolence with the god over the calamity by 'an offering of blood.' He still lived, however, and moved about in all the other existing owls of the country."*

"Faamalu, *Shade.* The name of a village god, and represented by a trumpet-shell. On the month for annual worship all the people met in the place of public gatherings with heaps of cooked food. First there were offerings and prayers to the god to avert calamities and give prosperity; then they feasted with and before their god, and after that any strangers present might eat. At the same settlement a marine deity

* *Id.*, 25.

called Tamauanuu, or *Plenty for the land,* was worshipped at the same time. On that day no one dared to swim on his back off the settlement, or eat a cocoanut. Any one transgressing would have to go to the beach and beat his forehead with stones till the blood flowed, so as to prevent his being devoured by a shark the next time he went to fish. In time of war Faamalu was also represented by a fish, the movements of which were watched. If it was seen to swim briskly they went to battle cheerfully; but if it turned round now and then on its back that was a veto on fighting. Faamalu was also seen in a cloud or shade. If a cloud preceded them in going to battle they advanced courageously; if, however, the clouds were all behind they were afraid. In a quarrel a mischief-maker would be cursed and given over to the wrath of Faamalu. If anything was stolen the sufferer would go along the road shouting and calling on Faamalu to be avenged on the thief.

"In another district Faamalu was only a war-god,—had a temple with a shell in it, and the shell was carried about with the troops."* We have here the beginnings of tribal or national religion (see under *d* below). Other examples of this might be given from Turner's lists and from Samoan mythology. We must allow for considerable borrowing from other islands.

The functional deity is also beginning to appear. As an instance I may cite "Fonge and Toafa. These were the names of two oblong smooth stones which

* *Id.*, 26-27.

stood on a raised platform of loose stones inland of one of the villages. They were supposed to be the parents of Saato, a god who controlled the rain. When the chiefs and people were ready to go off for weeks to certain places in the bush for the sport of pigeon-catching, offerings of cooked taro and fish were laid on the stones, accompanied by prayers for fine weather and no rain. . . . Any one passing by casually with a basket of cooked food would stop and lay a morsel on the stones. When such offerings were eaten in the night by dogs and rats, it was supposed that the god chose to become incarnate for the time being in the forms of such living creatures."*

The Fiji Islands, adjacent to Samoa, show the transition from animal to anthropomorphic deities. To quote Frazer's summary: "Dr. Rivers appears to be unquestionably right in holding that the sacred animals associated with tribes or sub-divisions of tribes in Fiji are totems in the process of evolving into gods, and that a more advanced stage in this evolution is represented by the village deities called *tevero*, which, though no longer conceived as animals, can yet assume at pleasure the shapes of those animals with which they were formerly identical; while the ancient totemic prohibition to eat of the totem survives in the rule which forbids the worshippers of the village god to partake of the particular creature, be it bird, or beast, or fish, into which their deity can thus transform himself. Such transformations throw light on the fables of ancient

* *Id.*, 24.

Egypt and Greece, which describe the metamorphoses of the gods into animals."*

This clan stage has left its impress on the history of religion in a number of ways. In the first place, in the association of gods and animals. Wherever, for example, we find the god accompanied by a sacred animal, we are fairly safe in putting it down as a survival from the time when some clan worshipped this animal as its god. It is doubtful whether such ideas could have *arisen* at a later stage of culture. They are helped out by traditions of were-wolves and other ideas involving kinship between animals and men, but these in their turn are probably survivals. The popular religion of Egypt remained practically on the same stage as that of Fiji, the animal god of the nome corresponding with that of the Fijian tribe.

In the case of the metronymic clan, wherever the animal-god of the clan became anthropomorphic it was apt to take the form of a woman, and many of the later goddesses and their worship are really survivals from this stage. As Robertson Smith has said: "Divine motherhood, like the kinship of men and gods in general, was to the heathen Semites a physical fact, and the development of the corresponding cults and myths laid more stress on the physical than on the ethical side of maternity, and gave a prominence to sexual ideas which was never edifying, and often repulsive. Especially was this the case when the change in the law of kinship deprived the mother of her old preëmi-

* Frazer, *op. cit.,* II, 140.

nence in the family and transferred to the father the greater part of her authority and dignity. This change, as we know, went hand in hand with the abolition of the old polyandry; and as women lost the right to choose their partners at will, the wife became subject to her husband's lordship, and her freedom of action was restrained by his jealousy, at the same time that her children became, for all purposes of inheritance and all duties of blood, members of his and not of her kin. So far as religion kept pace with the new laws of social morality due to this development, the independent divine mother necessarily became the subordinate partner of a male deity; and so the old polyandrous Ishtar reappears in Canaan and elsewhere as Astarte, the wife of the supreme Baal. Or if the supremacy of the goddess was too well established to be thus undermined, she might change her sex, as in Southern Arabia, where Ishtar is transformed into the masculine 'Athtar.' But not seldom religious tradition refused to move forward with the progress of society; the goddess retained her old character as a mother who was not a wife bound to fidelity to her husband, and at her sanctuary she protected, under the name of religion, the sexual license of savage society, or even demanded of the daughters of her worshippers a shameful sacrifice of their chastity, before they were allowed to bind themselves for the rest of their lives to that conjugal fidelity which their goddess despised."*

In an agricultural community, much of the demo-

* *Religion of the Semites,* 1894, p. 58.

cratic clan organization and religion is apt to persist long after the clan has become the village, a term of geography rather than of kinship. Thus, among the early Hebrews and their Canaanite neighbors in Palestine, each local community has its Baal, its "high place," and its joyous community feast in which the god is supposed to take part.

(*c*) *The patronymic stage,* as fully developed, which tends to reshape religious ideas on the model of paternal authority. This tendency shows itself in three principal directions.

1. Household worship. This is unknown until the patronymic stage and the rise of what may truly be called the family. Among the Samoans we have already noted a simple form of such worship. "The father of the family was the high-priest, and usually offered a short prayer at the evening meal, that they might all be kept from fines, sickness, war, and death. Occasionally, too, he would direct that they have a family feast in honor of their household gods; and on these occasions a cup of their intoxicating ava draft was poured out as a drink-offering. They did this in their family house, where they were all assembled, supposing that their gods had a spiritual presence there as well as in [their incarnations]. Often it was supposed that the god came among them and spoke through their father or some other member of the family, telling them what to do in order to remove a present evil or avert a threatened one. Sometimes it would be that the family should get a canoe built and keep it

sacred to the god. They might travel in it and use it themselves, but it was death to sell or part with a canoe which had been built specially for the god."* This household worship continues in various parts of the world, as in the teraphim which Rachel carried away from her father Laban, and in the goddess of the hearth in Greek and Roman families.

Another form of household worship appears early, either side by side with the other or superseding it. I refer to the so-called worship of ancestors. Practically all savage people have a veneration for the dead, arising from a very lively sense of the good or evil which a departed spirit may do if he chooses to return to the world on a visit. Patronymic man begins to have ancestors, whom he not only fears but also respects, as he was accustomed to do in life. It is an open question how far this homage can be considered as the worship of a supernatural being. The worshipper often distinguishes between ancestors and gods, and each class has its appropriate cult. But the line between the two is a shadowy one and is often crossed.

Our contemporary example is taken from the Amazulu of Natal, a feudal people properly belonging in the next stage. The spirits of the dead (Amatongo or Amadhlozi) are honored under the form of the snake. "When a snake comes into a house it is not killed; they say, 'It is the Idhlozi of So-and-so,' mentioning the name of a man who is dead; it is said that the snake came out of him at his death. It is left, and remains

* Turner, *op. cit.*, 18.

always in the house. They take a goat and sacrifice it, sacrificing to the snake. No one sees it when it goes away. When black men are on a journey they honor the snake. When a man is injured and gets well, he kills a bullock, for he thanks the Idhlozi, thinking that it has saved him. When a man obtains cattle also, he thanks the snake, thinking it is the snake which has given him many cattle. A man whose father is dead, when he is about to kill a bullock, worships his father, praying him to look on him continually, and give him all that he wishes, and give him cattle and corn,—everything. When a man is ill, they inquire of diviners; the diviner comes and tells them to eat a bullock. And they eat a bullock, the diviner saying that the man will get well. If when they have eaten the bullock he does not get well, but dies, they say, 'He is summoned by those who are beneath.' They say 'He has been killed by the Amadhlozi, because they wish the man to go and dwell with them.' "*

"Black people do not worship all Amatongo indifferently, that is, all the dead of their tribe. Speaking generally, the head of each house is worshipped by the children of that house; for they do not know the ancients who are dead, nor their laud-giving names, nor their names. But their father whom they knew is the head by whom they begin and end in their prayer, for they know him best, and his love for his children; they remember his kindness to them whilst he was living;

* Native relation, given by H. Calloway, *Religious System of the Amazulu,* Part I, 1868, p. 12.

they compare his treatment of them whilst he was living, support themselves by it, and say, 'He will still treat us in the same way now he is dead. We do not know why he should regard others besides us; he will regard us only.'"* The reader may put beside this the familiar descriptions of the ancestor worship of China, or the worship of the Lares in ancient Rome.

2. Remodelling of older gods. When, at any stage of organization, the patronymic idea becomes strong, a female divinity is apt to become male, as already noted.

3. The rise of tribal or district gods on the general model of the chieftainship. Some of the gods of the Baganda of Central Africa illustrate this tendency. To give a single example: "Kibuka has five priests. At one time Kibuka is said to have been sent by his father Wanema [another god] to assist one of the kings in a war against the Banyoro. When he arrived on the battle-field he went up into a cloud and cast down his assegais and shot arrows to the great discomfort of the enemy." They discovered the secret however and the next day shot arrows into the cloud, mortally wounding Kibuka, "whereupon he fled away some distance and died under a tree; later one of his priests found him and buried the body secretly, and making up a roll he placed it in a leopard skin and said it was Kibuka; the bundle was carried to Kibuka's hut, where it still remains. From that time he never went out again to battle in person, only the horn containing his ghost

* *Id.,* Part II, 1869, p. 144.

has been sent."* It would be of no special importance to know whether this is a case of a chief becoming a god, or of a god becoming a chief. The mental process involved in either case is much the same, and one that we should not be likely to find at an earlier stage. The Baganda are in the feudal stage (*d* below); the Santals of Bengal are a good example of independent patronymic tribes or clans.

Among the Amazulu we find not only ancestor worship but the worship of departed chieftains or kings. "It is said that one becomes a wasp; another a kind of lizard; another an imamba [a poisonous snake]; another a green imamba; but the greater number turn into the umthlwazi [a harmless snake], which may be green or brown. . . . The imamba are said especially to be chiefs, the lizards, old women, and the umthlwazi, common people."†

An American missionary, Lewis Grout, says: "Lions and elephants are sometimes looked upon as an embodiment of the spirit of their departed friends, especially their chieftains. Hence, should one of these animals visit their kraal, pass near or round it, without doing them any harm, they would say they had been favored with a visit from the spirit of their royal ancestor. To these shades of the dead, especially to the ghosts of their great men, as Jama, Senzangakona, and Chaka, their former kings, they look for help, and offer sacrifices; that is, slaughter cattle to them, and offer a sort

* J. Roscoe, *Journal of the Anthropol. Inst. of Great Brit.*, Vol. XXXII, p. 74.

† Calloway, *op. cit.*, Part II, p. 200.

of prayer, in time of danger or distress."* There is a similar apotheosis of departed kings in Buganda, the king's spirit being supposed to reside in his lower jaw, which is carefully preserved.

(*d*) The *patronymic confederation or kingdom,* and the rise of a national religion, side by side with local cults. This national religion may be of several types.

1. In the first type, as on the island of Tahiti, another set of gods has been added to the worship of the tribe or district. As described by Ellis, the Tahitians are governed by a hereditary king and hereditary district chiefs, under whom are the landed aristocracy, other freeholders, and various classes of dependents. Traces of earlier clan and tribal organization seem to have disappeared. The belief in spirits persists, and the witch-doctor does a thriving business. Every family of any antiquity has its own shrine and family god, the head of the family serving as priest. Each district has its temple, with a hereditary priesthood. There are gods of particular localities and professions, a series of demi-gods, "often described as having been renowned men, who after death were deified by their descendants"; hero gods of the sea and air, etc. As Ellis says: "Religious rites were connected with almost every act of their lives. An *ubu* or prayer was offered before they ate their food, when they tilled their ground, planted their gardens, built their houses, launched their canoes, cast their nets, and commenced or concluded a

* *Zulu-Land,* 1864, p. 137.

journey. The first fish taken periodically on their shores, together with a number of kinds regarded as sacred, were conveyed to the altar. The first-fruits of their orchards and gardens were also *taumaha,* or offered, with a portion of their live-stock, which consisted of pigs, dogs, and fowls, as it was supposed death would be inflicted on the owner or the occupant of the land from which the god did not receive such acknowledgment."*

Our special interest at this point is in the more distinctly national worship. A considerable pantheon has been developed in the mythology of Tahiti and neighboring islands and island groups. There are ten gods of the first order, with various functions, headed by Taaroa, as creator or father; a second order of gods serve as heralds between the gods and men; the third order seems to have been the descendants of Raa, an independent divinity of the first order; and there is a fourth or intermediary order, headed by Oro. The latter, the great national god of Tahiti and some other islands, was the son of Taaroa and his wife. "Oro took a goddess to wife, who became the mother of two sons. These four male and two female deities constituted the whole of the highest rank of divinities, according to the traditions of the priests of Tahiti."†

There are a number of national temples, the priests of which live in the temple precincts and form a dis-

* Wm. Ellis, *Polynesian Researches,* 1831, Vol. I, pp. 327, 350.

† *Id.,* 324.

tinct class. The shrines in the temple were large pyramidal structures, made up of a series of steps. In front of these were erected the altars, and the idols in which the gods were supposed to be present. "The idols of Tahiti were generally shapeless pieces of wood, from one to four feet long, covered with cinet of cocoanut fibers, ornamented with yellow and scarlet feathers. Oro was a straight log of hard casuarina wood, six feet in length, uncarved, but decorated with feathers. The gods of some of the adjacent islands exhibited a greater variety of form and structure."*

The worship consisted in preferring prayers, a number of gods often being invoked in succession, in presenting offerings and in sacrificing victims. The offerings consisted of every kind of valuable property—not only food but manufactured articles as well. Animals were sacrificed in whole or in part, and remained on the altar until decomposed. Human victims were also sacrificed in time of war or calamity, during the illness of their rulers, at the erection or rebuilding of their temples, and at great national festivals. The victim was usually killed elsewhere and the body brought to the temple. Portions of the hair took the place of the blood used in other sacrificial systems.

The origin of the various national gods of Tahiti is, in most cases, lost in obscurity. Some of them are evidently deified chiefs or heroes. Others must be clan gods, originally animal, which became anthropomorphic. The old habit of personifying nature and peo-

* *Id.*, 354.

pling it with spirits must still tend to replenish the supply of divinities. Other gods may be abstractions—functions, political divisions, characters in mythological stories and genealogies—which gradually have become concrete.

2. A second type of national religion shows a single god or pair of gods. In some cases this may be due to the fact that the worship of the king's family, clan or tribe was imposed on the nation. In other cases, as in Israel, the single national god antedates the kingship. Psychologically the process, whatever it was in detail, appears to resemble the development of the chieftain-god in the last stage. I do not recall any but historical examples. "Among the Semitic peoples which got beyond the mere tribal stage and developed a tolerably organized state, the supreme deity was habitually thought of as king. . . . We find that the Tyrian Baal bears the title of Melcarth, 'king of the city,' or more fully, 'our lord Melcarth, the Baal of Tyre,' and this sovereignty was acknowledged by the Carthaginian colonists when they paid tithes at his temple in the mother city; for in the East tithes are the king's due. Similarly, the supreme god of the Ammonites was Milkom or Malkam, which is only a variation of Melek, 'King.' "* Moab has its Chemosh, very much as Israel has its Yahweh. It is quite possible that in some of these cases further knowledge would disclose a group of national gods, as in Tahiti.

3. A third type or process is syncretism, the gradual

* *Religion of the Semites*, 66.

amalgamation of deities originally distinct. This is likely to take place at any stage, but is especially noticeable with the growth of nationality or with the consolidation of two nations or civilizations, whether peacefully or through conquest. The Ewe peoples of the Slave Coast of West Africa, in addition to district gods—largely animal—and local deities associated with natural objects, have a number of national gods. These are functional or natural: firmament, lightning, phallus, etc. A comparison with the less-developed Tshi people of the neighboring Gold Coast shows that these gods are abstractions of the functions of countless local gods. That is, the Ewe gods have been aggregated, while those of the Tshi are still segregated. Five or six hundred local lightning gods are blended into one general lightning god, who is everywhere represented by the same sort of image and is served with the same ceremonies. As a consequence of this blending, "there ensues a loss of the idea which caused a belief in the existence of the individual local god to arise. These local gods, originally held to be the indwelling spirits of certain local features or local phenomena, are severed from their local habitats and centered in one general god, with the inevitable result that the notion of the indwelling spirit disappears. Thus we find on the Slave Coast that the general deities are not the indwelling spirits of natural features; they are beings independent of any tangible abode."* Another interesting thing about the Ewe religion is that it represents a

* A. B. Ellis, *The Ewe-speaking Peoples,* 1890, p. 27.

transition from stage *b* to stage *d,* without passing through stage *c.* The people are in a process of change from mother-kin to father-kin.

The process was exactly similar for ancient Greece. To quote from Professor Fairbank's recent work: "We must assume that the conception of nature-spirits, of souls, of 'departmental gods,' was originally much the same for different communities, but nowhere quite the same, and that in the larger civilization which developed the gods of each type grew richer and more varied with elements drawn from different communities, different regions in the Greek world, and different sources outside of Greece. In this sense the Zeus or the Poseidon of the epic was a 'composite photograph' of earlier Zeuses and Poseidons. The process was one of synthesis or of 'condensation,' to use the word of Eduard Meyer. But if the Zeus of Homer was a composite photograph of earlier forms of the god, this is only half the story. Each cult of Zeus continued to emphasize those peculiar characteristics of the god which it had always emphasized, in addition to the characteristics generally adopted, with the result that the Zeus of each cult remained individual and was known in worship by an added individual name. Zeus Lykaios worshipped with human sacrifice in Arcadia, Zeus Trophonios worshipped in a Bœotian cave, Zeus Meilichios conceived now in human form, now in the form of a serpent, are extreme examples of this individualization preserved in worship. Each local cult modified the conception of Zeus for a narrower or wider region according to the extent of its influence; the god of each local cult was more or less modified by the general Greek conception of Zeus. Finally, it should be noted that there were some local gods which were never brought under any of the general Greek gods, and others, like the Zeus Amphiaraus of Oropus, who were thought of as distinct beings more often than as forms of Zeus."*

Of syncretism through conquest a single instance will suffice. When Khamurabi conquered the Euphrates valley about 2400 B. C., his own city, Babylon, became supreme among the other Babylonian cities. Marduk, the patron god of Khamurabi and Babylon, became the supreme god. This position had formerly been held by the old En-lil or Bel of Nippur. The two gods at once began to blend "into one personage, Marduk becoming known as Bel-Marduk, and finally, the first part of the compound sinking to the level of a mere adjective, the god is addressed as 'lord Marduk,' or 'Marduk, the lord.' The old Bel is entirely forgotten, or survives at best in conventional association with Anu and Ea, as a member of the ancient triad."†

4. Instead of syncretizing conflicting deities, men may gradually arrange them in an elaborate pantheon of relationships, functions and ranks, a process which we saw beginning in Tahiti. The royal religion of Babylonia is one long illustration of this process.

* Arthur Fairbanks, *Handbook of Greek Religion,* 1910, p. 212.

† Jastrow, *Religion of Babylonia and Assyria,* 1898, p. 118.

(*e*) The stage of *individual leadership,* within or without national lines. The prophet or reformer is not unknown in earlier stages, but his predominating influence implies a fairly high degree of culture. In Babylonia, and still more in Egypt, the priestly theologians refine away the crudities of the national mythology, give the gods a moral character, systematize them, and even reduce them to a theoretical monotheism. The same is true of Brahmanism, and probably of the religion of Persia. In Greece the process goes very much further, the philosophers doing for the religion of the educated a work either constructive or destructive, while the mass of the people cling to the old cults, or at least to their ritual. The remarkable ethical monotheism of the Jewish religion at its highest was due to the Hebrew prophets, especially those of the seventh century B. C. Mohammed built a new religion and nationality on the ruins of the old tribal religions of Arabia. For Christianity the factor of personal leadership has been prominent, not only in its founding by Jesus, but in the gradual development of its theology. Besides the Christianity modelled on the teachings of Jesus, there have been countless other Christianities, some of them shading off into polytheism.

Further discussion of this stage in the history of religion seems unnecessary here. The philosophical, ethical or "founded" religions defy classification. Each should be studied by itself, the student always remembering that the reigning theological system may be something quite different from the beliefs and practices of the ordinary worshipper. I have merely introduced the reader to the great field of comparative religion. The phenomena disclosed to us are numerous and important.

CHAPTER XIX

RELIGION AND PSYCHOLOGY

THIS chapter is intended as an introduction to the detailed studies which follow. We must determine in a general way the nature of religion, its relation to psychology, and the methods to be used in further investigation.

Historical study shows us that religion, like all the higher life of man, is an accumulation of ideas. It is found in the human mind and nowhere else. There is no religion in a church, an altar, a book, although these, through long association, may suggest religious ideas to the mind of some worshipper. To another worshipper they may suggest quite different ideas; a particular church building or altar or book may become an object of scorn or abhorrence. The history of religion furnishes countless instances. An animal or an infant gives no evidence of having a religion. Neither has it any arts or sciences. The reason for this is that an animal or an infant has no power of forming ideas, or at least ideas of a sufficiently complex character.

Religion, as an accumulation of ideas, necessarily varies with the individual, the local community, the tribe or nation. The difference between the Australian's religion and that of the Samoan, the Tahitian, or some one still higher in the scale, is that the former has gathered a different set of ideas as to spirits or gods and his relation to them. Not only are mythology and theology composed of ideas, but all worship, all conduct as affected by religion, is based on the concepts formed in the worshipper's mind.

Whatever the ultimate origin of religious ideas, they are acquired through a process of mental education. Why does the Tahitian fisherman pray to a certain divinity before launching his canoe? Because his father did so before him, and the community does so around him. That act of religion is as much a part of his education as is the making or handling of the canoe itself.

Religion is the accumulation of ideas about a particular side of human life. Without attempting a close delimitation of the field, we may say that these ideas relate to the soul of man, especially after death, and to the spirits supposed to surround man and to control his life and that of the universe. The religious man assumes that such a "spiritual" world exists, very much as the scientist assumes that the material world exists, or the artist assumes that the beautiful exists. These fundamental religious assumptions—the existence of controlling spirits, and a future life of some sort for the soul—are practically universal until the rise of philosophical scepticism. Even when they are formally repudiated traces of them are apt to remain in superstitious feelings or practices. Systems of thought which began by being agnostic or anti-religious, such as Buddhism, Confucianism, or even Positivism, tend to take on religious features.

These religious ideas may start in the mind of some individual genius, or in the social mind of the horde or village. On the other hand, they may be borrowed from the religious customs of other tribes. Although such borrowing is often very extensive, the parallelisms of religious thought and practice in various parts of the world are due chiefly to the tendency of men to think alike, to react in about the same way to the same experiences. If savage children could grow up apart from older persons, receiving no definite heritage of ideas, they would probably form a new religion, just as they would form a new language. And in a few generations the new religion or language would resemble the old in its general features.

Religion practically begins afresh with the education of each individual child. In one sense, there are as many religions in the world as there are people. Statements as to the conservatism of religion are largely erroneous. Beliefs and customs, except in rare circumstances of isolation, are constantly changing. A religion may be made over in a comparatively few generations. Striking instances of this are furnished by the history of Christianity or of one of its denominations or local churches, by the missionary work of Christianity and Mohammedanism, by the spread of Oriental cults in the Græco-Roman world.

At this point a distinction should be introduced. Some sides of religion are more conservative than others. Ideas descriptive of the gods and their actions change frequently, with the progress of thought or in the mere process of transmission from one mind to another. To take a contemporary example, there is a vast difference between the God of Lyman Abbott and the God of Jonathan Edwards. In later Greece, the Apollo of a local cult becomes a St. George. A deity will combine a number of characters originally belonging to different gods, as frequently happens in Assyria. Where the old idea becomes inconsistent, or its original meaning is lost, the worshipper adjusts his thinking by a myth, which is a new religious idea. The Apollo stories become St. George stories. Two distinct gods may be married, or thought of as different incarnations of the same deity.

Rites and customs, on the other hand, and ideas as to the sacredness of certain objects, are often remarkably persistent. The Apollo shrine lasts on, with much of the old ritual, after the change from Apollo to St. George. May-poles are still set up in a few English villages, perhaps a thousand years after they have ceased to have any real connection with the popular religious faith. The Christian worshipper is apt to pray toward the east, like his sun-worshipping ancestors. Otherwise intelligent people carry fetishes, and decline to start enterprises on certain unlucky days. A cabman in St. Petersburg is said to have murdered a woman passenger and then refused to eat her lunch, because it contained meat and he did not eat meat in Lent.

Many religious ideas undoubtedly originate in experience, and persist because they appear to be in accord with experience. A simple example is the idea of a theophany. "Tradition says that the people of Cape Coast first discovered the existence of Djwi-j'ahnu [the local deity of Connor's Hill] from the great loss which the Ashantis experienced at this spot during their attack on Cape Coast on the 11th of July, 1824. The slaughter was so great and the repulse of the Ashantis so complete, that the Fantis, accustomed to see their foes carry everything before them, attributed the unusual result of the engagement to the assistance of a powerful local god," and they set up a cult accordingly.* The persistence of such an idea would require further theophanies, or at least a strong tradition of this first theophany, together with the absence of counter-influences, such—for example—as new defects by their enemies, the rise of other popular cults, less need felt of supernatural aid, or the undermining of the superstition by Christianity.

Traces of a local cult like that just described may persist even in the presence of counter-ideas. Persistence of this sort, without confirmation from experience or even contrary to experience, it is convenient to distinguish as "survival." The general law governing survivals, in any sphere of thought, is that they become more frequent the farther the ideas are removed from practical experience and experiment. An English farmer will believe that the sun goes round the earth

* Ellis, *Tshi-speaking Peoples,* 40.

long after he has adopted a steam thresher. A Hindu will ride on a railway or a tram-car but break caste nowhere else. A church lighted by electricity will have wax candles burning before the altar. The Ptolemaic theory of astronomy, the system of caste, the use of wax candles in worship—such ideas survive, in the face of advancing civilization, because they are so remote from experience that their displacement requires a process of reasoning too complex for the average man.

Ideas of a spiritual world have shown remarkable persistence. The members of my recent congregation were as far removed as possible in material and mental culture from the Dakota Indians who possessed the same Minnesota Valley a century earlier. But I believe the assumptions of immortality and deity were as strong among my fellow-worshippers as in an Indian village. Their ideas of immortality and deity differ widely from those of the Dakotas, and in their religion there is very much less of survival and very much more of reasoning, but fundamentally their attitude toward a spiritual world is the same. They believe there is such a world, and they are shaping their life to a certain extent by such belief. They believe they are in communication with a God, speaking to him and receiving his messages and favors.

It is evident that the presumptions of psychology—the survival of the mind of man and the existence of a cosmic mind—have become the working hypotheses of religion. How are these hypotheses to be tested? As to the first, the existence of a mind or soul relatively independent of organism, any evidence which may be brought forward is subject to such a heavy discount as to be valueless. Appearances of departed spirits—in the transfiguration, for example—like spirit-possession and apparitions of the dead, may be explained more simply as the projection of the mind's own images or by telepathy. The evidence may in fact be good, but we cannot use it in philosophy because the argument is logically short-circuited. So with any evidence that the soul leaves the body to visit distant scenes.

Taking up the second of the religious hypotheses, our previous studies show that if there is a cosmic mind in communication with the minds of men, such communication will come, like suggestion and personal influence, through the subconscious rather than the conscious. This distinction greatly restricts the field of our investigation. Beliefs, institutions, forms and objects of worship, as creations of the conscious personality, are beyond our province. We need not go further into questions of religious encyclopædia, or religious evolution. With the crudity or beauty of forms, the truth or falsehood of creeds, we have practically nothing to do. Our study must be in the field of religious attitude and feeling, of habit and habit-forming, of unconscious influences and responses.

Ground has been well broken in this field by Starbuck, James, and others. From such writers I have drawn much of the material used. But the study of the subconscious in religion is so new that I must largely marshal my own facts and form my own canons for their interpretation. I propose to take up the following topics: Communion; Inspiration; Physical Effects; Conversion.

Before bringing any religious facts into court, it will be well to lay down certain general rules of evidence. No subconscious or conscious effects may be considered as evidence of "divine" communication or control until we have eliminated:

Rule 1. The possible influence of the surrounding crowd or community. Thus, in the early history of Kentucky, if a man began to "jerk" in a revival, it is natural to suppose that he did so because of the subconscious influence of others who had "the jerks." Again, in our study of religious experience, we must confine ourselves to individual rather than to public worship.

Rule 2. We must eliminate the influence (direct or telepathic) of another individual. If a priest says: go to a certain shrine and you will be cured of your lameness, the cure may properly be ascribed to the priest's suggestion, rather than to a divine influence operating through the shrine.

Rule 3. We must eliminate, as far as possible, the suggestion of a mind to itself, or the projection of its own images. Most visions may be explained by such suggestion or projection, as may also many answers to prayer, physical cures, moral improvements, etc.

In any of the above cases the religious explanation might be the true one. My point is simply that our philosophic laws of evidence rule it out of court. Philosophy deals not so much with what is true, as with what may be proved true, by inductive reasoning. Men after death may turn into animals, witches may ride on broomsticks, a rabbit's foot may keep off bad luck, but—we don't know it. The simplest explanation of the facts, drawn from the facts themselves in their various relations, must be allowed to stand until it fails any longer to make good.

My material will be taken from any religion in any stage. However much beliefs and forms may differ, the subconscious phenomena are largely parallel. All religions, from the lowest to the highest, stand or fall together. My chief source will necessarily be the experience of modern Christians.

I shall also make use of the religious experience of Jesus, and as to this a word of explanation is perhaps in order. Jesus the Christ, the Son of God, belongs to theology. The question of his nature must be settled, like all other questions of thought, not *a priori* or on authority, but from a study of all the facts of Christian history bearing on the question. Again, Jesus as a religious teacher and reformer belongs largely to a study of the conscious, not of the subconscious. But Jesus as a religious man, a religious genius, is a proper subject for investigation here. The record, though scanty, is as satisfactory as in most cases studied before the time of Edmund Gurney. A simple comparative study* shows that we have the following principal sources: (1) the Gospel of Mark, which forms the framework of the other synoptic gospels, a fresh yet stereotyped narrative, transmitted orally and in writing, and put in its present form before A. D. 70; (2) a parallel document, of about the same date, the "teachings" common to Matthew and Luke, and probably found also in some of the separate material preserved in each; (3) independent sources utilized by Matthew and Luke, especially the latter; (4) the letters of Paul, and other parts of the New Testament, as preserving the attitude of the early Christian community, and checking (1) and (2); (5) the gospel and epistles of John, of later date, rhetorical rather than biographical, giving Jesus' attitude on many points, as interpreted to a later generation by a disciple of Jesus or the disciple of a disciple.

From these sources it may not be possible to construct a biography of Jesus. The exact form of many of his teachings remains in doubt, especially as we have them only in translations from the Aramaic. The bias

* The physicist or biologist, entering the field of New Testament study, must be impressed by the unscientific character of most of the higher (as distinct from lower or textual) criticism. Where comparative study ceases (it carries us but a little way) we are unable to do more than guess, and guessing is not a scientific procedure. The two great needs are: a grounding in the principles of inductive logic, and a willingness on the part of both radical and conservative to acknowledge that they do not know. Curiously enough, in Old Testament work, the charge of subjectivity and dogmatism must be brought, not so much against the higher criticism, where much comparative study is possible, but against the textual criticism, most of which is pure guess-work.

of the editor or his source is often very apparent. But we can put together a very considerable number of sayings where the form is so original or so well-attested that we must have substantially Jesus' words. And, more important still for our present purpose, we can without difficulty reconstruct many features of Jesus' character and his attitude toward God.

CHAPTER XX

COMMUNION

WE may begin with mysticism, the supposed sense of the immediate presence of the divine. This is somewhat general in religion, at least in its later stages. I shall cite, from different periods, a number of cases where this element has been especially prominent. We must depend on the words of the mystic himself, but these are his attempts to express a (largely subconscious) feeling and attitude. In most of the cases cited we have some knowledge of the individual's life by which to check his words.

As already stated, almost all the examples must be from Christianity. Our historical knowledge of other religions is, with a few exceptions, derived from anonymous and impersonal literature. When the Rig Veda says: "Hear this my call, oh Varuna; be merciful to me today; for thee, desiring help, I yearn," we do not know who is speaking, or how far he is voicing a personal experience. And for contemporary Hinduism or Mohammedanism or Parseeism, no Starbuck has yet arisen.

There can be no doubt that the mystical element was strongly developed in Jesus. It comes out in contrast with the legal and rather materialistic Judaism of his time. At twelve years of age he says to his astonished parents: "Wist ye not that I must be about the things of my Father?"* That term "Father," found occasionally in Hebrew prophets and poets as descriptive of God, is adopted by Jesus to express the direct and personal relation of God to his world. Only a mystic would use such a phrase. Jesus sees God everywhere—in the color of the flowers, in the feeding of the birds, in the daily miracle of human existence, in all the events of life and history. Jesus' model prayer is the respectful but intimate address of a child to his Heavenly Father, of a junior partner to the great Head of the firm. In the Mark source, his own prayer in the olive orchard is given: "Abba, Father, all things are possible unto Thee; remove this cup from me: howbeit not what I will but what Thou wilt."† The phrase "my Father" occurs frequently in Matthew, and is found also in Luke. Other fragments of Jesus' prayers are given: "I thank Thee, oh Father, Lord of heaven and earth, that Thou didst hide these things from the wise and understanding, and didst reveal them unto babes: yea, Father, for so it was well-pleasing in Thy sight."‡ "Father, forgive them, for they know not what they do."§ "My God, my God, why hast Thou forsaken me?"|| "Father, into Thy hands I commend my spirit."¶

* Luke 2:49.
† Mark 14:36. The parallel, Matt. 26:39, gives "my Father."
‡ Matt. 11:25-26; Luke 10:21.
§ Luke 23:34.
|| Mark 15:34, given in Aramaic.
¶ Luke 23:46.

Jesus speaks with the sense of a direct authority from God, and not as an ecclesiastical lawyer, hiding behind precedents. He claims to be above the Scriptures, to be greater than the Temple, to be lord of the Sabbath. He commands, he invites, he assumes divine functions, like that of forgiving sins. This tone of authority excites wonder in the common people, antagonism among the Jewish rulers. Jesus apparently would center in himself the love and obedience of the world, not only during his own lifetime, but through all future ages. Thus: "All things have been delivered unto me of my Father; and no one knoweth the Son [or, who the Son is] save the Father; neither doth any know the Father [or, who the Father is] save the Son, and he to whomsoever the Son willeth to reveal Him."* "He that receiveth you, receiveth me; and he that receiveth me, receiveth Him that sent me."† "Every one who will confess me before men, him will the Son of man also confess before the angels of God: but he who denieth me in the presence of men will be denied in the presence of the angels of God."‡ It seems to have been on the charge of blasphemy, based on these and similar sayings, that he was condemned by the Jewish court.

This mysticism of Jesus, found in the synoptists, is still more prominent in the fourth gospel. This book, a mystical classic, is at the same time one of the puzzles

* Matt. 11:27; Luke 10:22.

† Matt. 10:40. *Cf.* Luke 10:16.

‡ Luke 12:8-9. Found also in Matt. 10:32-33, with some changes in phrasing. *Cf.* Mark 8:38.

of literature. It is impossible to know how far its tone of mysticism is contributed by the author and how far it is due to the influence and words of Jesus. But the expressions put in Jesus' mouth would appear to be quite in harmony with the picture already gained. Among them we note the following: "He that sent me is with me, He hath not left me alone: for I do always the things that are pleasing to Him."* "I and the Father are one."† "Believest thou not that I am in the Father, and the Father in me? The words that I say unto you I speak not from myself: but the Father, abiding in me, doeth His works."‡ "Even as the Father knoweth me, and I know the Father."§ "Even as the Father hath loved me, I also have loved you."|| "All things that are mine are Thine, and Thine are mine."¶ "I came out from the Father and am come into the world: again, I leave the world and go unto the Father."**

Paul is a mystic. He has heard a divine call.†† He sustains the closest possible relation with the ascended Christ, as representing God. Christ speaks and works through him.‡‡ "To me to live is Christ."§§ "I have been crucified with Christ; and it is no longer I who

* John 8:29.
† 10:30.
‡ 14:10.
§ 10:15.
|| 15:9.
¶ 17:10.
** 16:28.
†† Gal. 1:12.
‡‡ *E.g.* 1 Cor. 7:10; Rom. 15:18.
§§ Phil. 1:21.

live, but Christ liveth in me. And that life which I now live in the flesh, I live in faith, the faith which is in the Son of God, who loved me and gave himself up for me."* "He hath said unto me, My grace is sufficient for thee."† "I know Him whom I have believed."‡

Plotinus, the eclectic philosopher of the third century, says: "Since God admits no Diversity into himself, he is always present; and we become present to him whenever we put away Diversity from us. He does not seek us, as though he were forced to live for us; but we seek him and live for him. Although indeed we are ever revolving around him, we do not see him continually: but as a choir of singers which turns around the supreme Master may for a short while be distracted from contemplation of the Master, and blunder in the harmony, yet when they turn to him then everything is perfect once again, thus do we always revolve around God, even when we forget about it. But when we look towards him again, then is our utmost wish crowned, and we sing to him a Divine song, ever revolving around him." "Whoever has once seen the Divine understands what I mean; how, beyond, the soul flourishes into another life; and, on going right up to God—nay, on having already gone up to God, thus has achieved a share in God, and thus knows for itself the presence of the Choir-leader of veritable life." Plotinus attained this ecstatic union four times during

* Gal. 2:20.
† 2 Cor. 12:9.
‡ 2 Tim. 1:12.

the years Porphyry lived with him, and considered it an objective fact.*

Passing over the speculative mysticism of the medieval period, we come to Ruysbroek. From the active life, the spirit rises to the inner and finally to the contemplative life. "In this embrace and essential unity with God all devout and inward spirits are one with God by loving immersion and melting away into Him. . . . In this simple and intent contemplation we are one life and one spirit with God. And this I call the contemplative life. In this highest stage the soul is united to God without means; it sinks into the vast darkness of the Godhead."†

St. Teresa, besides experiencing occasional raptures and visions rivalling those of Plotinus, found in prayer a frequent access to the Divine. Her description of what she calls the fourth degree of prayer should be one of the classics of the subconscious, as well as of devotion. "The soul, while thus seeking after God, is conscious, with a joy excessive and sweet, that it is, as it were, utterly fainting away in a kind of trance: breathing, and all bodily strength, fail it, so that it cannot even move the hands without great pain; the eyes close involuntarily, and if they are open, they are as if they saw nothing; nor is reading possible,—the very letters seem strange, and cannot be distinguished,—the letters, indeed, are visible, but, as the understanding

* *Enneads,* VI, 9:8, 7; trans. by Guthrie, *Philosophy of Plotinus.*

† *De Ornatu Spiritualium Nuptiarum,* trans. based on Inge, *Christian Mysticism,* 170.

furnishes no help, all reading is impracticable, though seriously attempted. The ear hears; but what is heard is not comprehended. The senses are of no use whatever, except to hinder the soul's fruition; and so they rather hurt it. It is useless to try to speak, because it is not possible to conceive a word; nor, if it were conceived, is there strength sufficient to utter it; for all bodily strength vanishes, and that of the soul increases, to enable it the better to have the fruition of its joy. Great and most perceptible, also, is the outward joy now felt. . . . He who has had experience of this will understand it in some measure, for it cannot be more clearly described, because what then takes place is so obscure. All I am able to say is, that the soul is represented as being close to God, and that there abides a conviction thereof so certain and strong, that it cannot possibly help believing so. . . . In the beginning, it happened to me that I was ignorant of one thing—I did not know that God was in all things: and when He seemed to me to be so near, I thought it impossible. Not to believe that He was present, was not in my power; for it seemed to me, as it were, evident that I felt there His very presence."*

Here is another introspection of great interest. "I used to have at times, though it used to pass quickly away—certain commencements of that which I am going now to describe. When I formed those pictures within myself of throwing myself at the feet of Christ,

* *Autobiography,* trans. by David Lewis, London 1904, pp. 139 *ff.*

and sometimes even when I was reading, a feeling of the presence of God would come over me unexpectedly, so that I could in no wise doubt either that He was within me, or that I was wholly absorbed in Him. It was not by way of vision; I believe it was what is called mystical theology. The soul is suspended in such a way that it seems to be utterly beside itself. The will loves; the memory, so it seems to me, is as it were lost; and the understanding, so I think, makes no reflections—yet is not lost: as I have just said, it is not at work, but it stands as if amazed at the greatness of the things it understands."*

Inge has called attention to the fact that the great mystics, far from being unpractical dreamers, have been keen, energetic and influential. "Their business capacity is specially noted in a curiously large number of cases. For instance, Plotinus was often in request as a guardian and trustee; St. Bernard showed great gifts as an organizer; St. Teresa, as a founder of convents and administrator, gave evidence of extraordinary practical ability; even St. Juan of the Cross displayed the same qualities; John Smith was an excellent bursar of his college; Fénelon ruled his diocese extremely well; and Madame Guyon surprised those who had dealings with her by her aptitude for affairs. Henry More was offered posts of high responsibility and dignity."†

As examples of English mystics, Inge and others have overlooked the great Puritan leaders, in whom

* *Id.*, X, 1.

† W. R. Inge, *Christian Mysticism*, 1899, p. xi.

the strain of mysticism was very strongly developed. Oliver Cromwell, for instance, felt himself to be from moment to moment in the presence of God and acting under his guidance. I have marked the same in new-world Puritans, from William Bradford to Stonewall Jackson. Underneath the stoicism and the practical shrewdness has been an unsuspected emotional nature: a human tenderness and a lively sense of the divine.

George Fox might properly be classed among the Puritans. We find in him much the same combination of business shrewdness and good judgment, abstemiousness, restraint in ordinary speech (not in denunciation) and inward fire. As illustrating his more normal mystical experiences, I select the following. At Coventry, going to visit the jail, "the word of the Lord same to me, saying, 'MY LOVE WAS ALWAYS TO THEE, AND THOU ART IN MY LOVE.' And I was ravished with the sense of the love of God, and greatly strengthened in my inward man."*

Coming to modern times, we hear Henry Ward Beecher saying: "Christ stands my manifest God. All that I know is of him, and in him. I put my soul into his arms, as, when I was born, my father put me into my mother's arms. I draw all my life from him. I bear him in my thoughts hourly, as I humbly believe that he also bears me. For I do truly believe that we love each other!—I, a speck, particle, a nothing, a mere beginning of something that is gloriously yet to be when the warmth of God's bosom shall have been a

* *Journal,* Philadelphia ed., 79.

summer for my growth;—and HE, the Wonderful Counsellor, the Mighty God, the Everlasting Father, the Prince of Peace!"*

This sense of the divine, so strongly developed in the religious "genius," is almost equally common among the rank and file of the religious. (I refer merely to individual experiences, communion with the deity in public worship being excluded under Rule 1 in Chapter XIX.) Of thirty-five men and seventeen women questioned by Professor Coe as to the permanent element in their religious life, twenty men and seventeen women emphasized various kinds of satisfactory feeling, twenty-eight men and twelve women putting emphasis on the ethical side of religion.†

Answers like these were given to Starbuck's similar questionnaire: "I have the sense of a presence, strong, and at the same time soothing, which hovers over me. Sometime it seems to enwrap me with sustaining arms. God is a personal Being, who knows and cares for His creatures." "I have often a consciousness of a Divine Presence, and sweet words of comfort come to me." "I feel the presence of Jesus in me as life, force and divinity." "I have a sense of the presence of a living God." "I have heightened experiences when God seems very near." "I have a sense of a spiritual presence in the world." "My soul feels itself alone with God, and resolves to listen to His voice in the depths of spirit. My soul and God seek each

* Lyman Abbott, *Henry Ward Beecher,* 1903, p. 14.

† Geo. A. Coe, *The Spiritual Life,* 1900, pp. 252 *ff.*

other. The sublime feeling of a presence comes over me."*

Starbuck gives the following percentages† for the religious feelings experienced among adults, in the cases studied (one hundred and twenty females and seventy-two males).

Feelings	Female per cent	Male per cent
Dependence	27	36
Reverence	25	37
Oneness with God, Christ, etc.	27	29
Faith	17	23
Blessedness	13	13
Peace	7	4
Unclassified	14	20
None	5	1

The mystical experience may be more or less continuous. On the other hand, it may come only once or twice in a lifetime. Thus James gives the following from Starbuck's manuscript collection, the case being that of a man of twenty-seven. "I have on a number of occasions felt that I had enjoyed a period of intimate communion with the divine. These meetings came unasked and unexpected, and seemed to consist merely in the temporary obliteration of the conventionalities which usually surround and cover my life. . . . Once it was when from the summit of a high mountain I looked over a gashed and corrugated landscape extending to a long convex of ocean that ascended to the horizon, and again from the same point when I could see nothing beneath me but a boundless expanse

* Edwin D. Starbuck, *Psychology of Religion,* 1899, p. 327.
† *Id.,* 332.

of white cloud, on the blown surface of which a few high peaks, including the one I was on, seemed plunging about as if they were dragging their anchors. What I felt on these occasions was a temporary loss of my own identity, accompanied by an illumination which revealed to me a deeper significance than I had been wont to attach to life. It is in this that I find my justification for saying that I have enjoyed communication with God."*

James Russell Lowell tells a friend in one of his early letters: "The last cause of joy I will detail more at length. I have got a clue to a whole system of spiritual philosophy. I had a revelation last Friday evening. I was at Mary's, and happening to say something of the presence of spirits (of whom, I said, I was often dimly aware), Mr. Putnam entered into an argument with me on spiritual matters. As I was speaking the whole system rose up before me like a vague Destiny looming from the abyss. I never before so clearly felt the spirit of God in me and around me. The whole room seemed to me full of God. The air seemed to waver to and fro with the presence of Something I knew not what. I spoke with the calmness and clearness of a prophet."†

Mysticism has a large place in other religions—for example, among the Hebrews—though it is not always easy to isolate the individual experience from that of the community as a whole. It is the mystical rather

* *Varieties of Religious Experience,* 70.

† Letter to G. B. Loring, Sept. 20, 1842 (*ætat* 22). *Letters,* I, 69.

than the ethical type which is dominant among the religious leaders of the Orient.

Whether similar experiences are to be found among people in Christian countries who are not professedly religious is an interesting question, not yet studied.* There are indications that they are, at least to a certain extent. The intellectual content of the mystical experience depends of course on one's education. The experience has been known to take an unreligious form. James cites Walt Whitman in his communion with nature, and Marcus Aurelius: "Everything harmonizes with me which is harmonious to thee, Oh Universe. Nothing for me is too early nor too late, which is in due time for thee. Everything is fruit to me which thy seasons bring, Oh Nature: from thee are all things, in thee are all things, to thee all things return."† Hæckel says: "The astonishment with which we gaze upon the starry heavens and the microscopic life in a drop of water, the awe with which we trace the marvellous working of energy in the motion of matter, the reverence with which we grasp the universal dominance of the law of substance throughout the universe—all these are part of our emotional life, falling under the head of 'natural religion.' "‡ Somewhat similar expressions might be given from the English Positivists.

* The weakness of the standard questionnaires is that they have been confined almost entirely to persons professing religion, and largely to persons of one type.

† *Varieties of Religious Experience,* 84, 44.

‡ E. Hæckel, *Riddle of the Universe,* Eng. trans., 1900, p. 344.

The feeling of a divine presence finds its fullest expression in prayer. To a discussion of certain sides of prayer I devote the remainder of this chapter. The most valuable contribution of recent psychology is that of Miss Strong, in her doctor's dissertation. Starting with the rather extreme view of Professor Cooley that the human personality is a constant construction of interacting and conflicting selves, she considers prayer as the direct interaction of two selves, or personal ideas, "arising simultaneously in consciousness as the result of a tension. The end sought is the establishment of a wider self. One of these selves or personal ideas is the *me,* or self of immediate purpose and desire; the other is objectified as *alter.* The alter is, as object, the necessary means to the desired end, and this end is always another self, differing both from the me and the alter, and varying infinitely as the particular problem varies. The alter is, as personal object, an isolated element, not yet a part of an effectively systematized whole. The alters are not all the same alter; neither are the me's the same me."* To some philosophical bearings of this theory I shall return in Chapter XXIV.

The earliest use of prayer is undiscriminating. "The child does not discriminate his religious needs from his other needs. He has no specifically religious needs. He wants something, and he makes use of any and every means he can think of; prayer is one of those

* Anna Louise Strong, *Prayer from the Standpoint of Social Psychology,* 1908, p. 21.

means. And prayer is a means not very alien to the general content of his mental life, which is made up largely of personal ideas, to be influenced in 'personal' ways. He will use in prayer the same kind of whining entreaty, or the same attempts at bargaining, which mark his attempts to control other personal forces." The prayer of the savage is of the same sort. Much of this undiscriminating use of prayer lasts on in adult religious life, as in the case of the revivalist who, in answer to prayer, obtained a suit of clothes that fitted both his person and his means.*

Discrimination in the use of prayer may take place in two ways. With a growing distinction between personal and impersonal forces, the use of prayer in certain fields is given up because it does not "work." Again, there may be a gradual discontinuance of prayer because we become ashamed to use it in this way. Many college girls confessed with shame that they always prayed for success in examinations. "The prayer 'worked' beautifully; the criticism of its use was not scientific but ethical." "I have asked for all kinds of things," said another girl, "and I have usually got them, as far as I remember, but I always feel so horribly ashamed afterwards to think that I bothered God with such trifles. I don't do it much now."†

With some important classes of partially discriminating prayer we shall be occupied in the next two chapters. For the majority of educated persons, the use of

* *Id.*, 27 *f.*
† *Id.*, 33 *ff.*

prayer, whether rightly or wrongly, comes to be limited to cases in which the desired result may be obtained through an effect on the person praying. "In an article by F. O. Beck,* dealing with the results of a questionnaire on the subject of prayer, only five per cent of the respondents, all of whom habitually prayed, claimed that 'objective' answers to prayer, that is, answers which affected conditions outside the subject, were possible. . . . This doubt in the objectivity of prayer-answers is not due to a general decrease of belief in the efficacy of prayer, on account of numerous trials which have failed. For most of the respondents, to judge from the answers given, were people of strong religious conviction. The doubt represents rather a gradual distinction of the field in which prayer may appropriately be applied as a means."†

In what Miss Strong calls the completely social type of prayer—prayer used as a means for the establishment of a larger self—there are two tendencies. Of these the practical or ethical will be taken up in the chapter on Conversion. We are concerned here solely with the contemplative or æsthetic.

"Prayers of adoration, of meditation, of joy in the greatness of God, come under this head. 'Thou, Oh Lord, art from everlasting to everlasting' is a form of adoration in which the narrower finite self finds joy in the contemplative sharing of a wider, a mightier, an infinite life. In prayers of this type the me aims to

* *Am. J. of Relig. Psychol. and Education,* I, 115 (1906).
† *Id.,* 46.

lose itself completely in a sympathetic participation in the life of the alter, in such a way as to give up entirely all thought of an activity or problem of its own. This form is seen, at its extreme, in the Buddhist meditations, the aim of which is complete forgetfulness of the finite self. It is seen in less extreme forms in all types of religious-æsthetic absorption; it is seen when the psalmist, after mentioning with much lamentation his own trials, finds comfort in the fact, not that Jehovah will deliver him, but that Jehovah is mighty in Israel, and will ultimately win the day in the succeeding generations. Such prayer finds its chief end in the prayer-state, in the enlargement of the self through the contemplative sharing of a wider life, and in the peace, rest and joy therefrom resulting."*

The prayer of contemplation has already been illustrated by our quotations from St. Teresa and other mystics. It may take the form of self-surrender, as noted above. It is said of St. Francis that, in his early ministry, he had such a sense of God's grace that he could only say over and over, through the night, "My God, my God."† Absorption in the divine may be sought as an end in itself, bringing an æsthetic pleasure, a satisfaction of the spirit, similar to that found in music, art or natural beauty. Prayer may be merely the craving for a wider companionship.

The object sought may be rest for the storm-tossed spirit. "Prayer," says Herrmann, "is an inward con-

* *Id.*, 23.

† *Fioretti*, 2.

flict, which should normally bring the Christian up to a higher plane of the inner life; the sign of the attainment of this goal is the dying away of the storm of desire into stillness before God."* George Matheson writes: "In the hour of perturbation thou canst not hear the answer to thy prayers. The heart got no response at the moment of its crying,—in its thunder, its earthquake and its fire. But when the crying ceased and the stillness fell, when thy hand desisted from its knocking on the iron gate,—then appeared the long-delayed reply.—It is only in the cool of the day that the voice of the Lord God is heard in the garden."† Again, this blind poet sings:

"O Love that wilt not let me go,
  I rest my weary soul in thee:
I give thee back the life I owe,
That in thine ocean depths its flow
  May richer, fuller be."

This type of prayer may be used to gain nervous rest and recuperation. Its value in this direction has been proved by countless worshippers. "With Thee is the fountain of life." "All my fresh springs are in Thee."‡ Jesus, after a strenuous day, was accustomed to spend much of the night in prayer, on the solitary moor.§ Harriet Beecher Stowe, weighed down by the storm of abuse which her book had aroused, found a similar refuge in God:

* *Verkehr des Christen mit Gott,* quoted by Strong, 92.
† *Times of Retirement,* quoted by *id.*, 88.
‡ Ps. 36:9; 87:7.
§ Mark 1:35; Luke 5:16; Matt. 14:23.

"When winds are raging o'er the upper ocean,
And billows wild contend with angry roar,
'Tis said, far down beneath the wild commotion
That peaceful stillness reigneth evermore.

"Far, far beneath, the noise of tempest dieth,
And silver waves chime ever peacefully;
And no rude storm, how fierce soe'er he flieth,
Disturbs the sabbath of that deeper sea.

"So to the soul that knows thy love, O Purest,
There is a temple peaceful evermore!
And all the babble of life's angry voices
Die in hushed stillness at its sacred door.

"Far, far away the noise of passion dieth,
And loving thoughts rise ever peacefully;
And no rude storm, how fierce soe'er he flieth,
Disturbs that deeper rest, O God, in thee."*

Religion has proved a frequent relief in sorrow. Humanity has found no other relief, except in stoicism. J. R. Miller gives the following prayer, when a member of the family has died: "O God, our Father, we, Thy children, bow at Thy feet in our sorrow. To whom can we go but to Thee? We desire to submit ourselves to Thy will. Thou hast laid Thine hand upon us, and our hearts are broken. But in our grief we will trust Thee. Even so, Father; for so it seemeth good in Thy sight. We thank Thee for the comforts that come to us from the gospel, for the words of divine promise which whisper themselves into our hearts, for the assurance of the sympathy of Christ, who wept with His friends in their bereavement, for the blessed hopes of resurrection and immortality which come to us from the broken grave of the Redeemer. We rejoice

* *Religious Poems,* 1867, p. 32.

that our loved one who has fallen asleep is with Jesus—absent from the body, but present with the Lord. Wilt Thou quiet our hearts and comfort us? Give us Thy peace. Bless our broken home circle. May the memories of the vanished day stay in our hearts as holy benedictions. May our household life be all the sweeter for the grief that has touched it. We have no words to speak. We would get near to Thy heart; we would creep into Christ's bosom, into the everlasting arms, and be still. Bless us with the tenderest blessings of Thy love, we ask in the name of Christ, Amen."*

Again, prayer frequently takes the form of devotion, of gratitude, of thanksgiving. "Bless Jehovah, oh my soul; and all that is within me, bless His holy name. Bless Jehovah, oh my soul, and forget not all His benefits: Who forgiveth all thine iniquities; who healeth all thy diseases; who redeemeth thy life from destruction; who crowneth thee with loving kindness and tender mercies; who satisfieth thy desire with good things, so that thy youth is renewed like the eagle."† "O God, we thank thee for this universe, our great home; for its vastness and its riches, and for the manifoldness of the life which teems upon it and of which we are part. We praise thee for the arching sky and the blessed winds, for the driving clouds and the constellations on high. We praise thee for the salt sea and the running water, for the everlasting hills, for the trees, and for the grass under our feet. We thank thee

* *Family Prayers,* 194.
† Ps. 103:1-5.

for our senses by which we can see the splendor of the morning, and hear the jubilant songs of love, and smell the breath of the springtime. Grant us, we pray thee, a heart wide open to all this joy and beauty, and save our souls from being so steeped in care or so darkened by passion that we pass heedless and unseeing when even the thornbush by the wayside is aflame with the glory of God."*

Once more, prayer may be used to gain renewed faith in God and love toward him. Perhaps the best expression of this is found in Christian hymns, considered here merely as poems which voice the feeling of the author or of the individual worshipper.

"More love to Thee, oh Christ,
More love to Thee;
Hear Thou the prayer I make,
On bended knee."

"Oh for a closer walk with God,
A calm and heavenly frame."

"May Thy rich grace impart
Strength to my fainting heart,
My zeal inspire. . . .
Oh may my love to Thee
Pure, warm and changeless be,
A living fire."†

* Walter Rauschenbusch, *Prayers of the Social Awakening,* 1910, p. 47.

† Mrs. Prentiss; Cowper; Ray Palmer.

CHAPTER XXI

INSPIRATION

IN religion the claim is frequently made of an increase of knowledge by direct inspiration from the deity or in answer to a prayer, an incantation or a ritual act.

I take up first what might be called religious clairvoyance. Leaving aside the various methods practised in early religions, I pass at once to a modern instance, vouched for by Miss Strong. A college girl had lost her physics notebook, and an examination was drawing near. "She let it go till the last minute, hoping to find it. Then being in some concern, she made it a matter of prayer, saying: 'If it is Your will that I try the examination without this book as a punishment for my carelessness, very well; I will do my best that way. But it would make things much easier if I could find it.' She immediately felt an impulse to go to a certain store in the village. She reasoned with herself, saying: 'I haven't been there for over a month. I remember distinctly the last time I was there and that was before I lost the book.' The impulse continued, and taking it as an answer to her prayer, she went. As she entered, a clerk approached her with the book, saying: 'You left this here ten days ago, and I could not send it, not knowing your address.' Then and not till then the memory of a special visit made to the store by an unusual road, flashed across her mind."*

The difficulty in such a case is not the clairvoyance. The records of psychical research are filled with much more elaborate examples; often there will be a distinct vision of the object in a certain place. The psychological process is clear: the subconscious memory of the visit to the store, emerging when the conscious mind stopped trying to remember. The difficulty is in giving religion any necessary connection with the clairvoyance. The function of prayer would appear to be simply to give the subconscious a chance.

From clairvoyance I pass to clairaudience. The prophet in all ages has heard voices which he has considered divine, or received revelations which he felt to be beyond his own mental powers. Similar experiences are frequent in the life of the ordinary worshipper. It will be convenient to divide our cases into three classes: those where some new truth has been received, those where some practical direction is given, and those in which there is the element of prediction.

New truths are constantly being discovered by religious leaders. The study of later Hebrew prophecy furnishes instructive examples. Take their idea of God, in relation to his people. We have what appear to be a series of personal discoveries, growing out of the experience of the nation. Amos reaches the thought of an ethical and universal God. Hosea, through his domestic trials, learns to know God's suffering love.

* *Op. cit.*, 51.

Isaiah finds in God the Holy One, demanding a holy people, even if it were only a remnant. With Jeremiah the service of God comes to be individual and not merely social. Second, Isaiah saw in the faithful remnant the servant of Jehovah, suffering for humanity.

Practically every Hebrew prophecy is prefaced by a "Thus saith the Lord." In three instances some description is given of the process by which the truth is reached. Isaiah sees a vision of Jehovah in his heavenly palace, surrounded by angelic figures chanting: "Holy, holy, holy." He is overwhelmed by the sense of his own impurity and that of his people. And in the vision this uncleanness is removed by a symbolic act. Jeremiah, hesitating over his fitness to be God's messenger, has the divine hand placed on his lips, as a sign that God's words will be put in his mouth. Ezekiel, prostrate before the majesty and omniscience and power of the swiftly-moving Deity, is told to stand upon his feet, to receive the Spirit.*

The symbolic form of the visions of these men is more than literary embellishment or "Oriental" imagery. It is an indication that their discovery of truth, like similar discoveries in other fields, takes place through the subconscious. Symbolism is characteristic of certain levels of the subconscious mind, as we see in dreams. Psychologically, the vision of the prophet is very similar to Hilprecht's Babylonian priest, or Hudson's vision of a group of diamonds.† The experi-

* Isa. 6:1-8; Jer. 1:4-10; Ezek. 1:1—2:2.

† See *ante*, pp. 229, 254.

ences of Isaiah and Ezekiel are paralleled by those of Savonarola, of Swedenborg, and of Edward Irving, which will repay careful study. An extreme case is that of poor William Blake, who considered himself merely God's amanuensis.

Jesus claims to receive truth directly from God. "The Son can do nothing of himself, but what he seeth the Father doing: for what things soever He doeth, these the Son doeth also in like manner." "I spake not from myself, but the Father who sent me, He hath given me a commandment, what I should say, and what I should speak."* While we cannot rely on the form of these words, coming as they do from the fourth gospel, they undoubtedly give his general attitude. The temptation in the wilderness, necessarily related by Jesus himself, is an example of symbolism, and so probably of the subconscious mind emerging in the conscious.

Paul claims to speak by revelation. He carefully distinguishes what the Lord says from what is merely his own private opinion.† Just how he draws the distinction is not clear; the criterion seems to be an objective one: the previous revelation in the Scriptures and in Christ. The subconscious element was dominant in Paul's sudden conversion, which we shall see to be the almost universal rule.

One case of conversion may be described here, as relating to the personal discovery of a new truth. It

* Jno. 5:19; 12:49.

† *E.g.,* 1 Cor. 7:8-10, 25. *Cf.* Gal. 1:8-12.

is that of a lady brought up in entire ignorance of Christian doctrine. After being talked to by Christian friends, she read the Bible and prayed, and finally the suggestions thus implanted flashed upon her consciousness. "The very instant I heard my Father's cry calling unto me, my heart bounded in recognition. I ran, I stretched forth my arms, I cried aloud, 'Here, here I am, my Father.' Oh, happy child, what should I do? 'Love me,' answered my God. 'I do, I do,' I cried passionately. 'Come unto me,' called my Father. 'I will,' my heart panted. Did I stop to ask a single question? Not one. It never occurred to me to ask whether I was good enough, or . . . to wait until I should be satisfied. Satisfied! I was satisfied. Had I not found my God and my Father? Did he not love me? Had he not called me? . . . Since then I have had direct answers to prayer—so significant as to be almost like talking with God and hearing his answer. The idea of God's reality has never left me for one moment."*

George Fox has given us this account of the way the doctrine of the inner light dawned on his mind. "The Lord God opened to me, by his invisible power, how 'every man was enlightened by the Divine light of Christ.' I saw it shine through all, and that they that believed in it came out of condemnation to the light of life, and became children of it; but they that hated it, and did not believe in it, were condemned by it, though they made a profession of Christ. This I saw in the

* *Varieties of Relig. Experience,* 69.

pure openings of the light, without the help of any man; neither did I then know where to find it in the Scriptures; though afterwards, searching the Scriptures, I found it. For I saw in that Light and Spirit which was before the Scriptures were given forth, and which led the holy men of God to give them forth, that all must come to that Spirit, if they would know God, or Christ, or the Scriptures aright; which they that gave them forth were taught and led by."* From the language used and what we know of Fox's familiarity with Scripture, it seems evident that the passage in John 12:35-36 had lain dormant in his mind. Its meaning and application were organized, as it were, below the threshold.

Beecher's account of his loss of self-consciousness in preaching is somewhat parallel to the accounts already given of the oratory of Webster and Henry Clay.† "I have my own peculiar temperament; I have my own method of preaching: and my method and temperament necessitate errors. . . . I am impetuous. I am intense at times on subjects that deeply move me. I feel as though all the ocean were not strong enough to be the power behind my words, nor all the thunders in the heavens; and it is of necessity that such a nature should at times give such intensity to points of doctrine as to exaggerate them when you come to bring them into connection with a more rounded and balanced view. I know it. I would not do this if I could help it; but there are times when it is not I that is talking; when

* *Journal,* Philadelphia ed., 72.
† *Ante,* p. 227.

I am caught up and carried away so that I know not whether I am in the body or out of the body; when I think things in the pulpit that I could never think in the study, and when I have feelings that are so different from any that belong to the lower or normal condition that I can neither regulate them nor understand them. I see things, and I hear sounds, and seem, if not in the seventh heaven, yet in a condition that leads me to apprehend what Paul said,—that he heard things that it was not possible for a man to utter."*

Symbolism or the loss of self-consciousness is by no means necessary in this field of religion. Probably every true Christian minister begins both the preparation and the delivery of his sermons with a prayer for divine "inspiration," and receives what he considers a sufficient answer. In my own case, I can see no real difference, however, between sermons and other literary composition. Prayer in either case is an aid to concentration and to the full utilization of one's subconscious resources.

Our second group of cases is even more numerous, though we need not linger over them, as the psychological process involved is much the same. Prayers for practical guidance bulk very large in the experience of the average worshipper. Most Christians feel that their destiny is being shaped for them, either constantly or in the important crises of their lives. They naturally fall back on prayer in times of special difficulty.

A personal experience of my own will answer as well

* *Patriotic Addresses*, 1887, p. 140.

as that of another. I was once lost in the woods in the northern peninsular of Michigan, on a fishing excursion. It was growing dark, and I seemed likely to be compelled to spend the night in the wet forest. I stopped and prayed over the matter. Almost at once I heard the lowing of a cow. After following the sound in the darkness for about half an hour, I stumbled on a barbed-wire fence which marked the boundary of a settler's clearing.

Genuine prayers for guidance almost always bring the result desired. That is, they prepare us to use the ideas, images and impressions which emerge or are ready to emerge from below the threshold of ordinary consciousness. The prayer itself is always a powerful agent of suggestion. In the case described, suggestion may have quickened my attention or even my sense of hearing. The statesmanship so often shown by religious leaders—Hebrew prophets, Christian missionaries, bishops and other executives—is no doubt largely due to their habitual attitude of prayer. And the ordinary praying man, who goes about his work without haste or worry, feeling that his life is being planned for him, is likely to be more correct in his decisions and quicker to see opportunities.*

We come now to our third class of cases, those involving the prediction of future events. Unfortunately the materials for a proper study of this subject are somewhat meager.

* Some prayers of this class involving other persons it will be convenient to postpone until the next chapter.

George Fox tells us in his Journal that, coming to a mountain in Wales from which he could see a long distance, "I was moved to sound the day of the Lord there: and set my face several ways and told John ap Johns, a faithful Welsh minister, in what places God would raise up a people to set under his teaching: and those places he took notice of, and since there has a great people risen in those places: and the same thing I have been moved to do in many places and countries, the which have been rude places, and yet I was moved to declare the Lord had a seed in those places, and after there has been a brave people raised up in the covenant of God and gathered in the name of Jesus."* Such a prophecy might easily be a factor in its own fulfillment, through the action of telepathy.

What seems to be a well-authenticated case of prediction is Isaiah's preaching as to the inviolability of Jerusalem. This idea is of course intimately related to the rest of his teaching. The city is holy; it is necessary for the development of the holy people. But the prophet's insight is remarkable, and his faith superb. The Assyrian army moves across the land, apparently irresistible, but Isaiah tells the people not to fear them. He sees in the invading army merely Jehovah's instrument, the axe with which he hews. The prophet pictures them sweeping up to the very walls of Jerusalem. "This very day shall he halt at Nob: he shaketh his hand at the mount of the daughter of Zion, the hill of Jerusalem. Behold the Lord, Jehovah of hosts, will

* *Journal,* Cambridge 1911, I, 281.

lop the boughs with terror: and the high of stature shall be hewn down, and the lofty shall be brought low. . . . And there shall come forth a shoot out of Jesse, and a branch out of his roots shall bear fruit." "Therefore thus saith Jehovah concerning the king of Assyria, He shall not come unto this city, nor shoot an arrow there, neither shall he come before it with shield, nor cast up a mound against it. By the way that he came, by the same shall he return. . . . For I will defend this city to save it, for mine own sake, and for my servant David's sake."* History shows that this prediction was substantially fulfilled.

Strangely enough, by the time of Jeremiah the idea that Jerusalem could not be taken had become a dogma that apparently stood in the way of the divine plans. Jerusalem must fall, and, with the religious development that had taken place under Isaiah and his successors, exile would mean the saving of what was best in the Hebrew nation, and not its complete destruction as would have been the case a century earlier. Jeremiah clings to this prediction and faith, in the face of charges of disloyalty and the bitterest abuse and persecution. Like Isaiah he stood almost alone. The prophetic statesmen read the movements of history as their contemporaries are absolutely unable to do. Their optimism, as expressed in the ever-changing but never-dying Messianic hope, is nothing short of sublime. Jesus, who considered himself as fulfilling the ideal of the Messiah, turned his back like Jeremiah on the nar-

* Isa. 10, 11; 36, 37.

row patriotism of his day. To him the destruction of Jerusalem and of the Jewish Temple seemed inevitable, but the national history would find richer fruitage in a religion of sacrificial service for humanity.

Josephus gives the account of one Jesus the son of Ananus, four years before the outbreak of the Roman war which resulted in the destruction of Jerusalem. While peace and prosperity still prevailed in the city, this male Cassandra appeared, during the Feast of Tabernacles, and began to cry: "A voice from the east, a voice from the west, a voice from the four winds, a voice against Jerusalem and the holy house, a voice against the bridegrooms and the brides, and a voice against the whole people." Arrested and beaten, and then dismissed as a madman, he lived by himself, holding no intercourse with other persons and answering every question with his "Woe, woe to Jerusalem."*

History gives frequent instances of the same sort. Sometimes the prediction is an optimistic one, as when Queen Louise predicted in 1808 that Prussia would not be destroyed but finally victorious. In 1703 Leibnitz predicted the approach of a great revolution. Scipio had a foreboding of the later fate of Rome.† Such rather general premonitions need not detain us; their origin is not hard to explain. It should be noted that the shores of both secular and religious history are strewn with the wrecks of unfulfilled prediction.

There remain the cases of religious premonition

* *Jewish War*, Bk. VI, 5:3.

† J. H. Kaplan, in *Am. J. of Psychol. and Rel. Ed.*, II, 179.

which find fulfillment in the individual's life. But these are so bound up with similar cases from the annals of psychical research, as yet little understood, that we are at liberty to dismiss them. Even when fully authenticated, with the careful elimination of coincidence and of premonitions which bring their own fulfillment, they teach us nothing new as to the way in which religious knowledge is gained.

Summarizing the studies of this chapter, we may say that inspiration in religion must take its place beside the inspiration of art or music, literature or science. All depend largely on the emergence of subconscious impressions into consciousness. How far an external cosmic mind is involved is a philosophical question. All we can say here is that the subconscious is the vehicle through which divine inspiration must act, provided that a God, in something of the Christian sense, is present. Inspiration in itself cannot be taken as evidence of such a presence, since it is always possible that our third rule, excluding the suggestions of a mind to itself, should be applied.

CHAPTER XXII

PHYSICAL EFFECTS

THE power of curing disease has been claimed by all religions, with the exception of Protestant Christianity during a part of the nineteenth century. From the multitude of well-authenticated cases, I cite a few which will illustrate various types.

Here is a case of spontaneous self-cure, from the narrative of that heroic enthusiast, George Fox. Once, when struck down by a mob, "the power of the Lord sprang through me and the eternal refreshings refreshed me, that I stood up again in the eternal power of God and stretched out my arms amongst them all and said again, with a loud voice, Strike again, here is my arms, my head and my cheeks." At that a mason struck the top of his hand with his walking staff. The hand was so bruised that he could not draw it up, and the people cried that it had been spoiled for any further use. "And after a while the Lord's power sprang through me again and through my hand and arm, that in a minute I recovered my hand and arm and strength, in the face and sight of them all."*

Here is the case of self-cure in answer to prayer. It is related by Dr. Torrey, the evangelist. "A fit of

* *Journal,* Cambridge 1911, vol. II, 58.

illness came upon him when alone in his study. He was in such pain that he was unable to arise and seek help. Fearing lest he should be left alone and unaided for an entire night unless he secured the strength to care for himself, he prayed, and in a few moments was greatly relieved."*

We turn next to the miracle-working shrine. The following are among the cures which are known to have taken place at Lourdes. "Catherine Latapiè-Chouat fell from an oak tree in October, 1856. Her arm and hand were badly dislocated. The reduction of the dislocation was performed successfully; but, in spite of the most intelligent care, the thumb, index, and middle fingers remained fixedly bent, and it was neither possible to straighten them nor to make them move in any way. The idea of going to the Massabielle grotto, six or seven kilometres away from her home, came into her mind. She got up at daybreak, and after praying, went to bathe her hand in the marvellous water. Her hand immediately *straightened out;* she could open and shut her fingers, which had become as flexible as they were before the accident."

"Marie Lanou-Domeugé, twenty-four years old, had been troubled with incomplete paralysis of the whole left side for three years. She could not take a step without help. Hearing the Massabielle spring spoken of, the peasant sent some one to Lourdes one day to bring a little of this healing water from the source itself. She was helped to get up and dress; two people

* *How to Pray*, quoted by Strong, *op. cit.*, 55.

lifted her and she stood, both of them supporting her by the shoulders. Then she stretched out her trembling hand and plunged her fingers into the glass of healing water, made a large sign of the cross, put the glass to her lips and drank the contents slowly. Then she straightened herself up, shook herself, and cried out in triumphant joy: 'Let me go! Let me go quickly! I am cured.' And she began to walk as if she had never been paralyzed."

"Mlle. de Fontenay, twenty-three years old, had a paralysis of her lower limbs for nearly seven years. It developed after two falls, one from a carriage and one from a horse, which had given her a great shock, and had provoked uterine disease. Two seasons at Aix, homeopathy, hydro-therapeutics, the actual cautery, all these different forms of treatment had failed. From the end of January, 1873, she could no longer stand on her feet. She had, moreover, sharp internal pains, and attacks of nervous irritation. On the 21st of May, 1873, she went to Lourdes. During the course of a nine days' devotion, her strength gradually came back; after the devotional season was over, July 3, she could follow the procession on foot. But the day after Pentecost, the paralysis reappeared. She tried a season at Aix again in vain, at Brides, at Bourboule, and came back to Autun feeble, paralyzed and demoralized. Under the influence of religious suggestions, her imagination was gradually exalted again. On May 4, 1874, Bernadotte appeared to her in a dream, and promised her that she should be cured. In August, she accompanied the Abbot of Musy to Lourdes, who was himself miraculously cured of a paraplegia. She was plunged into the pond several times, and then taken to the cave in a carriage. This was on August 15, the anniversary of the Abbot Musy's cure, and at the same place where he was cured. During mass read by the abbot, she felt a slight pricking in her limbs; after the mass was over she rose; she was cured."*

Here is a case from Christian Science. "The patient suffered for twenty years from a form of paralysis and most of the time losing more and more control over her limbs, the latter eight years being completely paralyzed in her lower limbs, and partially in the arms, and she was so helpless that others had to carry her downstairs to her couch or bathchair in the morning, and upstairs to bed at night, when she was well enough to leave her bed at all. The attending medical man at this period, when asked his opinion of the future progress of the disease, replied plainly in effect, that there was no hope of any cure, but a very grave fear that she would steadily grow worse and that a fatal termination in the near future was not at all improbable—and then he followed this up with a strong recommendation to her to try Christian Science, because he had known of a case in his own practice of partial spinal paralysis being healed by this treatment. The patient, after consulting with her relatives and also with the one healed by Christian Science, to whom her doctor had referred, ap-

* Lasserre, summarized by Bernheim, *Suggestive Therapeutics,* Eng. trans., 200 *ff*.

plied for Christian Science treatment. During the first treatment given, the Christian Scientist had the joy of witnessing the active return of movement in the paralyzed limbs, at first in an involuntary and uncontrollable swinging of the legs under the bedclothes. There had been no movement of these limbs for nearly eight years. In the early morning after the Scientist's visit, which had been paid in the evening, the patient made her sister get up, light the gas and help her out of bed, saying she 'felt sure she could walk.' She arose and walked around her bed. Their great joy may be imagined. The healing was so rapid that in two or three days she was able to go out, walking about the town."*

I now cite, for comparison, some cases with which religion had nothing to do. Voisin relates the casual treatment, in the square of a French city, of a peasant woman, forty years of age, who for two years had "suffered from various nervous ailments, indicating hysteria. After an attack six months before she became paralyzed in her right arm, and after a second attack she had a contracture in it. The arm was now hanging lax and it could not perform the slightest motion; her wrist and fingers were so much bent inward that the long nails had caused wounds in the hand; the articulations of her fingers were swollen and tender. All attempts to straighten the fingers only produced severe pain and increased contracture. Feeling remained in the arm and the muscles were not atrophied. I hypno-

* W. F. W. Wilding, M.D., quoted by Flower, *Christian Science*, 77.

tized her within a quarter of an hour. She fell into a deep sleep and was insensible, and her limbs were completely relaxed. With loud voice I now ordered her to straighten the little finger of her right hand. She complied, but with great difficulty and with signs of pain. Encouraged by this success, I asked her to straighten the ring-finger; she did that also; then the middle finger; this seemed to be more difficult, but she succeeded at last, after which the remaining finger and thumb were easily straightened. Her hand was fully stretched, although it evidently hurt the swollen joints; but she moved her fingers with increasing facility, and the contracture had entirely disappeared. Her arm was still immovable. I then ordered the invalid to move her arm and assured her that she could do it; she succeeded, at first with difficulty, but finally so that she moved it as easily as the left one. The bystanders regarded the cure as a miracle. Four months later, I received the information that the woman was well and could use her arm for every purpose."*

"A woman was brought on a couch into a London hospital by two ladies, who said she had been suffering from incurable paralysis of the spine for two years, and having exhausted all their means in nursing her, they now sought to get her admitted, pending her removal to a home for incurables. In two hours I had cured her by agencies which owed all their virtue to their influence on her mind, and I walked with the woman half a mile up and down the waiting-room, and

* Quoted by F. Björnström, *Hypnotism,* p. 93.

she then returned home in an omnibus, being completely cured."*

"M. L., a little girl of six, was sent to me from the West, in November, 1901, under a death sentence from a number of specialists. Her urine contained six and one-quarter per cent of sugar; the daily quantity voided was sixty-five ounces; and the specific gravity, 1038. Three treatments by suggestion were given after the child was asleep in bed at night, with the result of entirely eliminating the sugar, of reducing the specific gravity to 1017, and the daily amount of urine to twenty-four ounces—all in the space of ten days."†

General Grant tells us that on the night before Lee's surrender he was suffering very severely from a sick headache. He stopped at a farmhouse and spent the night bathing his feet in hot water and putting mustard plasters on his wrists and neck. Next morning, riding to take his place at the head of the column, he received an answer from General Lee, consenting to negotiations for surrender. "When the officer reached me," he says, "I was still suffering with the sick headache; but the instant I saw the contents of the note I was cured."‡

The problem of prayer for the sick has shifted completely since Professor Tyndall and his friends threw down their "prayer-gauge" in 1872. Then the question was a purely physical one: can we obtain any evidence that physical causes are affected by the requests

* A. T. Schofield, M.D., *The Unconscious Mind,* 393.
† J. D. Quackenbos, *Hypnotic Therapeutics,* 1907, p. 116.
‡ *Personal Memoirs,* 1885, pp. 483 *ff.*

of devout persons? As the Christian public declined the challenge, the field was rather left to Mr. Galton, the only party who had any real evidence to offer: statistics showing practically equivalent death-rates among the more and the less devout classes.

Today the question is a psychological one. The fact that mind influences the bodily condition is generally accepted. The working of suggestion has been illustrated repeatedly in our chapter on The Subconscious. The effect may be direct, or it may be indirect through the action of telepathy. When Hudson, for instance, cured over a hundred cases by telepathy* (a claim for absent treatment which I hope may be checked by further experiments), he was practically taking up Tyndall's challenge. He was indicating how easily physical causes may be affected by a strong will acting at a distance. But suppose Hudson's suggestions had taken the form of prayer. There is no way of telling whether the divine mind had anything to do with the effect on the minds and so on the bodies of the patients. It is evident that all cures performed in answer to prayer, or by other religious means, are excluded as direct evidence, by the application of Rule 2. The same is true of stigmatization and other bodily effects.

As far as the individual is concerned, prayer is undoubtedly a therapeutic agent of the greatest value. The Emmanuel Movement, operating on strictly scientific lines, makes repeated use of it. Religion tends to promote an attitude of mind—an absence of worry,

* *Law of Psychic Phenomena,* 191 *ff.*

of fear, a confidence, an optimism—which is an important element in the proper functioning of the organism. Wounds and fractures heal more quickly; there is less likelihood of contracting contagious diseases. The effect of prayer on the nervous system was noted in the last chapter. In extreme cases, as the history of martyrdom shows, religious faith is able to deaden completely the sense of pain. Prayer brings strength for battle or for any physical effort. But the suggestions of a mind to itself must be excluded by Rule 3.

One of the most remarkable cases in the annals of prayer is that of George Müller, the devoted German-English philanthropist, who came to depend entirely on this source for his own maintenance and that of his various enterprises. In establishing the orphans' home in Bristol, he began with prayer for suitable premises, for one thousand pounds in money, and for helpers to take charge of the children. Two days later he received his first gifts: a shilling and a piece of furniture. A public meeting followed, on December 9, 1835, and then two published letters, stating calmly the nature of the enterprise, the plan which was to be followed in carrying it out, the immediate needs and the fact that he confidently expected them to be met in answer to his prayer. The work was begun on a small scale the following spring. The financial stringency was often great, but equally great was the faith of Müller and his fellow workers. In one case the annual report was held for five months, in order that no public appeal might interfere with the operation of prayer alone.

Sometimes after breakfast there was no means in sight for dinner for a hundred persons. Occasionally a meal was delayed because the necessary food was late in appearing. Everything was paid in cash; no debts were incurred. By 1856 two hundred and ninety-seven children were being cared for, and a total of £84,441 had been received. In all, five large orphanages were built and maintained. Over 121,000 persons were educated in his day-schools. Over two million copies of the Scriptures, in various languages, were distributed, besides many million books and tracts, and several hundred missionaries were sent to the foreign field. A total of nearly a million and a half pounds was accounted for. Besides what was received directly for the work, Müller himself, a poor man, who had literally followed the injunction to sell all that he had and give to the poor, donated during his lifetime £81,490, out of money given him for his own use in cash or legacies.

What can we say of a record like this? Whether God had anything to do with it, or not, it is evident that Müller was constantly suggesting to the Christian public the nature of the work and its needs. His implicit faith made a powerful appeal. Psychologically the suggestion was all the stronger because it was indirect, rather than through direct solicitation. I have heard the late President Strong of Carleton College state that in his money-raising, in which he was very successful, he never made a direct request for money, but simply prayed over the matter and then described the work to the persons whom he was led to visit. Our second rule must again be applied. I am not desirous of disproving the answer to prayer in such cases, even if it were possible to do so; I have myself had experiences of the same sort. It is simply that where an alternative explanation may be given, the evidence as evidence must be ruled out of court.

Religious experiences involving what is known as "providence" are less easy to deal with, partly because the evidence, although voluminous, is almost entirely anecdotal. To attempt to sift the cases would hardly be worth the labor. Some of them would prove to be exaggerations, others mere coincidences. Telepathic warnings undoubtedly have large place, but about these there is nothing distinctively religious; in fact most of the cases studied by The Society for Psychical Research have no connection with religion.

The prayer of the religious man for protection for himself and others certainly has this value: it is an adjustment to the universe and its forces. It cultivates both a sense of dependence, and a faith in an overruling order, in a standard of value higher than that of merely physical weal or woe. It helps the worshipper to become reconciled to whatever happens—even to rejoice in it. This note is very prominent in religious literature; for example, in the Book of Psalms.

CHAPTER XXIII

CONVERSION

ON no side of religious experience has modern psychology been more fruitful than in the study of the change known as conversion. The pioneer in this field was President G. Stanley Hall of Clark University, and the investigation has been carried further by his pupils and by many others. The most thorough work is that of Professor Edwin D. Starbuck, now of Leland Stanford University.

Let us look first at the mental revolution which takes place during adolescence. "Conversion," says Starbuck, "does not occur with the same frequency at all periods in life. It belongs almost exclusively to the years between 10 and 25. The number of instances outside that range appear few and scattered. That is, *conversion is a distinctively adolescent phenomenon.*"* This is shown by the chart which he gives, plotted from the cases of two hundred and fifty-four females and two hundred and thirty-five males. Similar results have been obtained by other observers. "We may safely lay it down as a law, that among the females there are two tidal waves of religious awakening at about 13 and 16, followed by a less significant period at 18; while among the males the great wave is at about 16, preceded by a

* *Psychology of Religion,* 28.

wavelet at 12, and followed by a surging up at 18 or 19."*

Although the cases tabulated are confined to persons who had experienced a definite conversion, and make no allowance for those who had not, substantially the same crisis is known to occur in all normal young people. This has been recognized, not only in the revival meeting, and in the confirmation and first communion of ritual churches, but, at least as regards males, in the ceremonies attending the change from youth to manhood among almost all early religions, from the Churinga mysteries of the Central Australian or the solitary vigil of the American Indian to the solemn induction into citizenship in ancient Greece.

What is adolescence? Physiologically, it marks the functioning of the reproductive organs, which is completed in the female most frequently at the ages of thirteen or fourteen, and in the male about two years later. Other physiological changes occur, such as heightened blood-pressure, and greater exhalation of carbonic acid, indicating more active metabolism. Girls increase rapidly in weight from ten or eleven up to thirteen and less rapidly after that age. In boys there is usually a sudden acceleration in both height and weight at the age of ten, and a rapid increase in weight from thirteen to sixteen. From these figures and from a study of individual cases Starbuck has deduced the laws that the period of most rapid bodily growth is the time when conversion is most likely to

* *Id.*, 34.

occur, and that conversion and puberty tend to supplement each other in time, rather than to coincide.*

The mental changes involved in adolescence are even more important. The best description which I have seen is that drawn by Professor Coe, from the standpoint of the American Christian community, the only community adequately studied. The reader may verify it by the memory of his own experience. Though applying particularly to boys, the same things may be said of girls, with some modifications.

"The term adolescence, as now commonly used by psychologists, designates the whole period of approximately a dozen years from the first premonitions of puberty to the completion of the change to adult life. The mental development during this period is directly correlated with the physical. As the child now comes into possession of all the powers that belong to the species, and thus becomes a determining factor in it, so his feelings and his intellectual horizon rapidly widen out. There is greater independence, and yet greater consciousness of social dependence. The social instinct, in fact, now for the first time comes to blossom. There enters into the life a new sense of how others think and feel, and a self-conscious effort after social life and social adjustment. Life means more. Naïvely individualistic the youth cannot be; if he is selfish, it is only by a more or less conscious wrenching of himself out of his normal adjustment.

"We found the child mind occupied with impres-

* *Id.,* 38, 41.

sions and caring little for the universal. It is just the other way with the mind of the youth. The universal infatuates him, while the particular is likely to appear as a delay and a hindrance. He becomes a dreamer enamored of ideals and ravished with ambitions. Nothing but the greatest is great enough for him; nothing but the perfect has any worth or beauty. When he was a child his attention was absorbed by the things about him; but now the new feelings and powers blossoming within him direct his mind inward, and he becomes self-conscious, bashful, introspective, critical. The most prominent thing about him is sensibility, and this may become so acute that he shrinks from life, conceals himself, and eats his own heart in solitude. He may become incommunicative, secretive, lonely, or he may seek support in the friendship of a clique of youths who, being of his own age, can appreciate him.

"Just as the youth's own life grows inward, the things about him get an inner side also. It is now that beauty in nature assumes its mystical, fascinating quality. He thinks of things as having mysterious ultimate principles which he would fain penetrate. He has confidence in his ability to understand all mysteries if only he could get the right clew. He no longer takes things merely as they appear, nor is he willing to take anything for granted. Nothing short of absolute, indubitable truth, the true inwardness, the complete subjectivizing of everything, can satisfy him. Nothing short of absolutely right conduct can be right at all. He hates all imperfections, all compromises. What other persons call prudence seems to him to be disloyalty to principle. He will penetrate to the heart of moral law. Heretofore morality has imposed itself from outside, and right conduct has consisted in obedience to formal rules; but now he begins to inspect the rules themselves, and, though he may question them, he finds within his own breast a law-giver more exacting and terrible than any external rules. Though he passes out from under the tutelage of social law, he approaches in his own consciousness only so much nearer the awful seat of right.

"It is now that he becomes a conscious logician. A passion for argumentation takes possession of him. He will settle everything by rigorous logic. It was at this period of life that Descartes entered upon the course of thought that produced his principle of doubting everything that can be doubted. The adolescent is a remorseless critic. There is no limit to his captiousness and censoriousness. The least slip in pronunciation, the least infelicity of rhetoric, the least fault in dress, in manners, or in conduct, is seized upon wherever found, and playmates, teachers, pastor, and parents pass under the rod of his scorn. Then appear pride, conceit, self-will, and rebellion against authority.

"But all this time the youngster has been applying this whole merciless process to himself. He debates with himself more than with any one else. He criticizes himself; he agonizes for his faults. Most of all, perhaps, he will wring the secret of existence from himself. The childish 'why', which used to be asked out of playful curiosity, has now given place to a serious questioning upon which the issues of life and death appear to hang. And because the 'why' of life does not respond to his insistent pleadings he becomes puzzled and perplexed, possibly impatient with life itself. 'Why was I born? What am I good for?' he asks in torturing uncertainty. He may find relief in religion, or he may merely brood and worry, or he may take the easy road of doubt and scepticism. Because his power to ask questions exceeds the wisdom of the wisest to answer, the absolute mystery of being presses down upon his spirit as if to crush it.

"But this creature of intense emotion, and of intense, though narrow, intellectuality, has not corresponding power of action. He can conceive great things, he fancies himself doing great things, but here he stands only less helpless than a child. This is partly because his whole being tends to turn in upon itself and thereby loses the relief that comes from free self-expression. Here, then, are conditions altogether extraordinary. The adolescent can neither continue the free, individualistic, objective life of childhood, nor does he yet perceive how to adjust himself to the larger life. He is likely to become awkward in both body and mind, and the consciousness of this awkwardness may constitute for him a tragedy."

"The broader, deeper questioning as to the meaning of life, together with the blossoming of the social instinct, brings the need of a new and more deeply personal *realization* of the content of religion. The quickened conscience, with its thirst for absolute righteousness; the quickened intellect, with its thirst for absolute truth; the quickened æsthetic sense, with its intuitions of a beauty that eye hath not seen and ear hath not heard; the quickened social sense, with its longing for perfect and eternal companionship—in short, the new meaningfulness and mystery of life—all this tends to bring in a new and distinct epoch in religious experience. If one has not been religious in childhood, now is the supremely favorable time for conversion; and if one has been religious, there is still need, in most cases, for a personal decision and personal acceptance that shall supersede the more external habits of childhood."*

Starbuck has worked out the following table, showing the relative frequency of certain motives and forces which lead to conversion.†

MOTIVES AND FORCES PRESENT AT CONVERSION	Females %	Males %	Both Sexes %
1. Fear of Death or Hell	14	14	14
2. Other Self-Regarding Motives	5	7	6
3. Altruistic Motives	6	4	5
4. Following out a Moral Ideal	15	20	17
5. Remorse, Conviction for Sin, etc	15	18	16
6. Response to Teaching	11	8	10
7. Example, Imitation, etc.	14	12	13
8. Social Pressure, Urging, etc.	20	17	19
Sum of 1 and 2—*Self-Regarding* Motives	19	21	20
Sum of 3 and 4—*Other-Regarding and Ideal* Motives	21	24	22
Sum of 1 to 5—SUBJECTIVE Forces	55	63	58
Sum of 6 to 8—OBJECTIVE Forces	45	37	42

* *The Spiritual Life*, 35 *ff.*

† *Op. cit.*, 52.

Other important conclusions are drawn by the writer in this connection. The effect of the revival, he finds, is not so much to awaken highly emotional states, as to "appeal to those instincts already at work in consciousness, and which would probably show themselves spontaneously a year or two later." About one-fifth of the entire number of Starbuck's conversions (more frequently those of the males) took place independently of any immediate external influence. Among females, at least, the self-regarding motives (fears, etc.) predominate in the earlier years, but gradually decrease. Altruistic and moral-ideal motives tend to take their place, predominating after fifteen. The sense of sin increases up to the early years of adolescence, then gradually decreases, being connected perhaps with the rapid nervous changes. "Feeling plays a larger part in the religious life of females, while males are controlled more by intellection and volition." A close connection is shown between temperament and the character of the religious experience.

Coe's studies are of interest in this connection. He finds that three sets of factors favor the attainment of a striking religious transformation: first, a sanguine or melancholic temperament, in which sensibility is especially prominent, rather than intellect or will; second, the strong expectation of a change; third, passive suggestibility, such as is found in good hypnotic subjects, and a tendency to automatisms, either motor—for example, uncontrollable laughter—or sensory, as in dreams and hallucinations. Just as in hypnotism, the tendency to auto-suggestion while under the operator's influence is likely to cause the subject to resist. Seventy-seven cases (fifty-two males and twenty-five females, mostly college students) were carefully studied and sifted. "Of ten cases in which there is expectation of a marked transformation, together with the predominance of sensibility and passive suggestibility, the number whose expectation was satisfied was nine. But of eleven cases of such expectation, together with the predominance of intellect or of will, and with spontaneous auto-suggestion, not one was satisfied." Such a study has an important bearing on the motor and visual automatisms which have appeared in religious communities in all ages. And to the first group of his cases, as Coe discovers, "belong nearly, if not quite, all the persons who have experienced the healing of disease by faith, those who have received remarkable assurance of answered prayer in advance of the event, and those who reported other veridical premonitions."*

The will is an important factor in determining the direction which the change will take, if it comes. "There are two essential aspects of conversion, that in which there is self-surrender and forgiveness, accompanied by a sense of harmony with God; and that in which the new life bursts forth spontaneously as the natural recoil from the sense of sin, or as the result of a previous act of the will in striving toward righteousness."†

* *Op. cit.,* Chap. III.

† Starbuck, 100.

Another of Starbuck's tables shows the relation between the conscious and subconscious elements in conversion, the latter decreasing gradually with age:*

	Male		Female	
CONSCIOUS ELEMENT	% of whole Number	Av. Age	% of whole Number	Av. Age
Conscious Element Absent . .	2	11	19	11.8
Less than unconscious . . .	34	13.6	42	13.2
Equal to unconscious . . .	36	16.2	19	14.6
Greater than unconscious . .	26	17.4	17	15.4
Entirely dominant (or nearly so)	2	18	3	17

Our writer finds that, in the experiences preceding conversion, the consciousness of sin is much more dominant than that of the life toward which one is tending. The transformation is largely worked out "in the sphere of undefined feeling, and a relatively small part comes as mentally illuminated aspiration. . . . It seems to be a step in growth which calls into activity the deeper instincts. . . . The feelings, which are the primal elements in consciousness, function strongly. In the tendency to resist conviction we see, also, an indication that the new life is forcing its way even against the person's will. If we turn to the bodily affections, our evidence grows yet stronger. Conversion is a process which exercises the whole nature, and frequently disturbs the equilibrium of the physical organism. First and most often to be disturbed are sleep and appetite, the most primal organic functions. In the affections of sense, likewise, it is significant that touch, the mother-sense, is most affected. Accordingly, we may conclude

* *Id.*, 104.

that conversion is a process in which the deeper instinctive life most strongly functions."*

"An immediate result of conversion is to call the person out from himself into active sympathy with the world outside." Definite returns along this line were tabulated in percentages:†

RESULT OF CONVERSION	Females	Males
Desire to Help Others	28	28
Love for Others	42	42
Closer Relation to Nature	31	34
Closer Relation to God	43	43
Closer Relation to Christ	6	4

At the same time there is a new self-consciousness, a heightened sense of the value of the self. Latent mental powers are developed. The bodily health, which is likely to suffer during the experiences leading up to conversion, is generally improved when the crisis is passed. There is increased happiness and peace. Moral changes are even more striking: bad habits are given up, temper and other instincts are under better control.

A closer study of Starbuck's cases would exclude a large proportion of them, according to our rules of evidence. We should find them due directly to mob-suggestion, hypnosis, the strong urging of pastor or friends, the suggestions of a mind to itself. At the same time the somewhat general experience of conversion—its close connection with adolescence, its net result in the improvement of the individual, the estab-

* *Id.*, 64.

† *Id.*, 128.

lishment of a larger self, a self in more complete and normal relation with its environment—is a fact of the highest importance.

Such changes are of immense value in the life of the community and of the race. Whatever methods are used to bring them about—whether the lonely vigil in the forest while circumcision is healing, or the revival service, or the quieter pressure of home and church training—religion in some form is the determining factor. Without religion, the adjustment, as far as the matter has been studied, seems to be either lacking entirely or more one-sided. Starbuck has shown in one of his chapters* that while an ethical interest may be continued or even heightened during the storm and stress of adolescence, in the absence of a definite religious experience an intellectual or æsthetic interest becomes prominent in a large number of cases. To this is due, probably, the intensity and the narrowness of many scholars and artists in later life. The adolescent is father of the man. More frequently, in the absence of a higher appeal, the new self becomes absorbed in interests that are merely utilitarian, or in the gratification of animal instincts and cravings.

Starbuck, in a further analysis of his cases, is led to distinguish two types of conversion, which he characterizes as *escape from sin* and *spiritual illumination*. "The first type, escape from sin, is more nearly akin to breaking a habit. It is characteristic of all the older persons studied, and of all, regardless of age, who had led way-

* *Id.*, XXI.

ward lives. It is connected with the feeling of sinfulness proper, in which the mental state is negative, and attended by dejection and self-abnegation. The second type, which we have inadequately termed spiritual illumination, seems to be the normal—at any rate, the most frequent—adolescent experience. It involves a struggle after larger life, and is largely positive, although often accompanied by uncertainty and distress. After praying, and struggling and striving, the light dawns, new insight is attained, and there is joy and a sense of freedom in the new possession. This latter type is attended, to be sure, with much the same feelings just before the crisis as is the escape from sin, but in this case they are mere incidents to the central fact that the new insight is difficult to attain. There is the same juxtaposition in both instances of two inharmonious lives, the old and the new. In the escape from sin the conflict is between a life that has been lived—a sinful, habitual life—and the life of righteousness; while in the other type the conflict is between a life that is not—an incomplete, imperfect, aspiring self—and the life which is to blossom out and be realized." The two types are often blended. "Of those cases which belong rather distinctly to one or the other type, there seem to be about six times as many which follow the sense of incompleteness as the escape from sin. There are more of this type in both sexes, and in both revival and non-revival groups. It is the rule for the non-revival females to belong to it."*

* *Id.*, 85 *ff.*

These two types are found also in the many experiences of conversion in adult life, from the time of St. Paul onward. Reversing the order, I give two examples of "spiritual illumination" to which James has called attention. The first is the well-known case of David Brainerd. In his twenty-second year, after long agonizing of spirit, he reached the point where he realized his own unworthiness and inability. "When I saw evidently that I had regard to nothing but self-interest, then my duties appeared vile mockery of God, self-worship, and a continual course of lies. . . . I continued, as I remember, in this state of mind, from Friday morning till the Sabbath evening following, July 12, 1739, when I was walking again in the same solitary place. Here, in a mournful melancholy state, I was attempting to pray; but found no heart to engage in that, or any other duty; my former concern, and exercise, and religious affections were now gone. I thought the Spirit of God had quite left me; but still was not distressed; yet disconsolate, as if there was nothing in heaven or earth could make me happy. And having been thus endeavoring to pray (though being, as I thought, very stupid and senseless) for near half an hour, then, as I was walking in a dark, thick grove, unspeakable glory seemed to open to the apprehension of my soul. I do not mean any external brightness, for I saw no such thing; nor do I intend any imagination of a body of light somewhere away in the third heavens, or anything of that nature; but it was a new inward apprehension or view that I had of God, such as I never had before, nor anything which had the least resemblance of it. . . . My soul was so captivated and delighted with the excellency, loveliness, greatness, and other perfections of God, that I was even swallowed up in him; at least to that degree, that I had no thought at first about my own salvation, and scarce reflected that there was such a creature as myself. . . . I continued in this state of inward joy, peace, yet astonishment, till near dark, without any sensible abatement; and then began to think and examine what I had seen; and felt sweetly composed in my mind all the evening following. I felt myself in a new world, and everything about me appeared with a different aspect from what it was wont to do. At this time, the way of salvation opened to me with such infinite wisdom, suitableness, and excellency, that I wondered I should ever think of any other way of salvation; was amazed that I had not dropped my own contrivances, and complied with this lovely, blessed, and excellent way before."* James calls attention to the simultaneous ripening of the one affection and the exhaustion of the other, in the subconscious.

By way of comparison I take an example with which formal religion had nothing to do, the conversion of Horace Fletcher from worry to peace.

" 'You must first get rid of anger and worry,' said a friend, speaking of the self-control attained by some Japanese through their practice of the Buddhist discipline.

* Edward's *Life of Brainerd,* Worcester 1793, p. 24.

" 'But,' said I, 'is that possible?'

" 'Yes,' replied he, 'it is possible to the Japanese, and ought to be possible to us.'

"On my way back to the Parker House, I could not think of anything else but the words, 'get rid,' 'get rid'; and the idea must have continued to possess me during my sleeping hours, for the first consciousness in the morning brought back the same thought, with the revelation of a discovery, which framed itself into the reasoning, 'If it is possible to get rid of anger and worry, why is it necessary to have them at all?' I felt the strength of the argument, and at once accepted the reasoning. The baby had discovered that it could walk. It would scorn to creep any longer. From the instant I realized that these cancer spots of worry and anger were removable, they left me. With the discovery of their weakness they were exorcised. From that time life has had an entirely changed aspect. Although from that moment the possibility and desirability of freedom from the depressing passions has been a reality to me, it took me some months to feel absolute security in my new position; but, as the usual occasions for worry and anger have presented themselves over and over again, and I have been unable to feel them in the slightest degree, I no longer dread or guard against them, and I am amazed at my increased energy and vigor of mind;—at my strength to meet situations of all kinds, and at my disposition to love and appreciate everything."*

* *Menticulture,* 1897, p. 26.

Examples of illumination and adjustment, transitional between this case and the former, might be given from Buddhism and from eclectic Hindu sects, or from New Thought and Christian Science. "The spirit of infinite life and power that is back of all," says Trine, "is what I call God. I care not what term you may use, be it Kindly Light, Providence, the Over-Soul, Omnipotence, or whatever term may be most convenient, so long as we are agreed in regard to the great central fact itself. God then fills the universe alone, so that all is from Him and in Him, and there is nothing that is outside. He is the life of our life, our very life itself. . . . The great central fact in human life is the coming into a conscious vital realization of our oneness with this Infinite Life, and the opening of ourselves fully to this divine inflow."*

For illustrations of sudden conversion from a life of sin, I turn to Harold Begbie's remarkable study of the work of the Salvation Army in West London.† It will be worth while to describe one of these at some length; it is typical of them all.

The case is that of a man who from boyhood had been possessed by the passion for crime. He apparently had no sensual appetites, and used public houses merely as convenient rendezvous. His parents were respectable Irish people, Roman Catholics, and the other children responded to home and church training. Danny was the black sheep of the family. "He was like a stone

* Ralph Waldo Trine, *In Tune with the Infinite,* quoted by James, *op. cit.,* 100.

† *Twice-Born Men, A Clinic in Regeneration,* 1909.

to his schoolmasters, imbibing nothing, and indifferent to chastisement. He played truant from church. He refused to say his prayers. He regarded the whole life of the home with contemptuous disfavour. Never once, he says, was he conscious of any desire to learn, to be good, to work and get on in the world. Always, from his earliest remembrance, he resented discipline and loathed effort."

At fourteen Danny took to the streets and became the leader of a gang of youths who lived by crime. He and his pals took brutal delight in fighting weaker and less criminal bands of roughs, or assaulting and maltreating solitary policemen. His frequent arrests and imprisonments only hardened him in crime. He represents, as Begbie says, the lowest type of criminal; there was no imaginable mean thing that he would not have done.

"It came about that Danny was arrested and sentenced to a long term of imprisonment soon after the conversion of the Puncher. Of course, he had heard of that miraculous event, and, of course, he had laughed over it with some of the Puncher's old mates in the lodging-houses. But in prison, realizing the weary time of monotonous suffering ahead of him, the conversion of the Puncher stuck in his mind and haunted his thoughts. He knew that the Puncher was better off as a saved man than as a drunkard. He imagined the Puncher's home, his fare, his good meals, nice clothes, his liberty unshadowed by fear of police. Then he considered within himself how bad and low the Puncher had been, a 'hopeless' drunkard. It seemed to him a wonderful thing that a man so abandoned to drink, and such a man, should all of a sudden give it up. He was quite dazed and staggered by the thought. What a drunkard, what a frightful drunkard, the Puncher had been; and now he was clean and respectable! For days the prisoner fed his mind upon this thought in the solitude of his cell. Alone in that little cramped space of stone, locked in, and without sight of tree, sky, or moving creature, the hardened criminal reflected upon the 'fair marvel' of Puncher's conversion. And one day revelation came to this base and savage mind. It came suddenly, without miracle, and it did not in the least stagger him. He started up with the thought in his mind, 'If God can save Puncher, He can save me.' "

"To reach God, he understood, prayer was necessary. So he got upon his knees in the prison cell, and offered his first prayer. He was a young man, and twelve whole years out of his short life had been passed in gaols; he had never had an opportunity of understanding religion; he had never given the idea of God a moment's thought. But he knew just enough of the matter to kneel. In what spirit he knelt one cannot exactly say: the important thing is that this depraved brute did kneel, and did pray. He says that he prayed throughout his long sentence, and *hoped* that when he left prison fortune would smile upon him, that it would be 'all right.' "

When he came out the Puncher met him, and talked with him: about the rotten life he had been living, about the power of God to wipe away sins and give his soul a new birth. The criminal was impressed, but his thoughts were still on a material level. His chief problem was how to manage steady work.

"Danny came to the Salvation Army meeting; he felt a light of illumination break through his soul at the adjutant's assurance of God's *love* for the worst of men; he realized all of a sudden the need for love in his own barren heart, and in that spirit—the spirit of a broken and contrite heart—he knelt at the penitents' form, and for the first time really reached into the infinite. He prayed for mercy; he prayed for strength.

"He rose from his knees a changed man. This change was absolute and entire. From being cruel, he became tender as a woman. From being a cunning thief, he became scrupulously honest. From being a loafer and unemployable, who had never done a single day's work in his civil life, he became an industrious workman. From being basely selfish, he became considerate for others, giving both himself and presently his money to the service of religion. 'The greatest change in Danny,' said a friend who knows him well, 'is his gentleness. He couldn't hurt a fly now, and any tale of cruelty or suffering, especially where children are concerned, fairly breaks him down.'"

As a study in psychology such a case is of profound interest. We see the sudden appearance of a new personality. Whence did it come? Unlike the known cases of secondary personality, this new character remembers its previous "part." In some ways it is like Janet's Léonore, appearing, though never consciously, from the deeper levels of the subconscious; or the last and completest Sally Beauchamp; or the improved Mary Reynolds. In the example before us, early training appears to have left no impressions on the subconscious mind. Some religious ideas however were undoubtedly gained from the surrounding community. The suggestion of a new character came from without: the story of the prizefighter's conversion suddenly taking possession of the criminal's interest, maturing into the conviction that the new character was possible, that *he* might play it, further matured by the Puncher's personal interview, budding in the Salvation Army hall at the adjutant's appeal, and finally blossoming as the man kneels at the penitents' bench.

The nearest analogy is the moral improvement, equally striking though more gradual, wrought in some well-attested cases by hypnotic suggestion.* Similarly, hypnotism is frequently used to destroy the appetite for alcohol. As an agency in this direction religion may be far more powerful. Both point to depths of personality otherwise unsuspected. No matter how depraved the conscious personality has become, there would appear to be in every man or woman a "mind" capable of being called out, in consciousness, into a new symmetry, utility and beauty. The religious experience which is able to do this, which has done it in

* See *ante*, p. 253.

many cases and perhaps may do it in all, if interested persons are present to suggest and the will of the subject makes the necessary surrender, is a fact of the highest social value and significance.

Apart from definite conversion, or in many cases supplementing it, we see a quieter reconstruction going on in the adult religious life. The process appears to be substantially the same: the formation of a larger self, more social, more self-controlled, better able to understand and adjust itself to its place in the world's life. Starbuck and others have studied this reconstruction in detail, but there is no occasion to dwell on it here. It may take the form of a new emotional experience, or "sanctification." It may be a deepening of faith, or a new understanding of duty, or a series of such illuminations. Sometimes it is an intellectual adjustment. Again, the process may be completely reversed. The adjustment may fail at some one point, or at many points, and involve religion itself in its failure.

Religious growth without definite transitions is shown by Edward Everett Hale in his answer to Starbuck's questions. The experience is probably common among those of a certain temperament who have been brought up under positive and wholesome religious influences. "I observe, with profound regret," he says, "the religious struggles which come into many biographies, as if almost essential to the formation of the hero. I ought to speak of these, to say that any man has an advantage, not to be estimated, who is born, as I was, into a family where the religion is simple and rational; who is trained in the theory of such a religion, so that he never knows, for an hour, what these religious or irreligious struggles are. I always knew God loved me, and I was always grateful to Him for the world He placed me in. I always liked to tell Him so, and was always glad to receive His suggestions to me. To grow up in this way saves boy or youth from those battles which men try to describe and cannot describe, which seem to use up a great deal of young life. I can remember perfectly that, when I was coming to manhood, the half-philosophical novels of the time had a deal to say about the young men and maidens who were facing the 'problem of life.' I had no idea whatever what the problem of life was. To live with all my might seemed to me easy; to learn where there was so much to learn seemed pleasant and almost of course, to lend a hand, if one had a chance, natural; and if one did this, why, he enjoyed life because he could not help it, and without proving to himself that he ought to enjoy it. I suppose that a skilful professor of the business could have prodded up my conscience, which is, I think, as sensitive as another's. I suppose I could have been made very wretched, and that I could have made others very wretched. But I was in the hands of no such professor, and my relations with the God whose child I am were permitted to develop themselves in the natural way."*

Prayer, in the more developed religions, is largely concerned with the desire for forgiveness and for

* *Psychol. of Relig.*, 305.

moral improvement. This need finds expression in ritual:

"O Varuna, loosen whatever sin we have committed to bosom-friend, comrade, or brother; to our own house, or to the stranger; what (we) have sinned like gamblers at play, real (sin), or what we have not known. Make loose, as it were, all these things, O god Varuna, and may we be dear to thee hereafter."*

"The sin I have committed change to mercy,
The wrong I have done, may the wind carry off.
Tear asunder my many transgressions as a garment.
My god, my sins are seven times seven, forgive me my sins.
My goddess, my sins are seven times seven, forgive me my sins.
Known or unknown god, my sins are seven times seven, forgive me my sins. . . . "†

"In the name of the merciful and compassionate God. Praise belongs to God, the Lord of the worlds, the merciful, the compassionate, the ruler of the day of judgment! Thee we serve and Thee we ask for aid. Guide us in the right path, the path of those Thou art gracious to; not of those Thou art wroth with; nor of those who err."‡

"Have mercy upon me, oh God, according to Thy loving kindness: according to the multitude of Thy tender mercies, blot out my transgressions. Wash me

* *Rig Veda,* V. 85; Hopkins, *Religion of India,* 66.

† Babylonian ritual tablet; Jastrow, *Relig. of Bab. and Assyria,* 321.

‡ *Koran,* Sura I; Palmer's trans.

thoroughly from mine iniquity, and cleanse me from my sin. For I know my transgressions, and my sin is ever before me. . . . . Hide Thy face from my sins, and blot out all mine iniquities. Create in me a clean heart, oh God, and renew a right spirit within me."*

"Our Father, who art in heaven, hallowed be Thy name. Thy kingdom come; Thy will be done, as in heaven so on earth. Give us this day our daily bread. And forgive us our debts, as we also have forgiven our debtors. And bring us not into temptation, but deliver us from evil."†

As religion grows inward and personal, prayer in this field comes to be of the greatest practical value. It holds before the worshipper a high standard of thought and life. It begets increased confidence in one's own power to resist and to attain. And through the shifting of part of the moral burden on that higher Power, which is a reality for the religious experience whatever it may prove to be for philosophy, it induces the calm and confident attitude of mind which is the condition of subconscious influence. Moral improvement and habit are due far more to suggestions from below the threshold than they are to conscious striving. For this reason, religious faith is undoubtedly the most powerful moral instrument known to man.

In Christianity, and to a very limited extent in other religions, of which it is the flower, the religious experience frequently takes the form of practical activity Starbuck found some form of altruism to be the

* Ps. 51:1-3; 9-10.

† Matt. 6:9-13.

governing ideal in fully one-half of the adults studied, as distinct from mere self-perfection.* Coe's investigations showed a somewhat similar division between feeling and activity. In the masculine religious experience, an ethical and especially an other-regarding motive is likely to be dominant, in later life.†

Jesus, the religious genius of history *par excellence,* while feeling most deeply the sense of communion, put the emphasis on practical service. "Why call you me, Lord, Lord, and do not the things which I say? Every one who cometh unto me and heareth my words, and doeth them," is like a man who built his foundation on the solid rock.‡ His program was social: "to preach good tidings to the poor, to bind up the broken-hearted, to proclaim liberty to the captives, and the opening of the prison (or, of the eyes) to them that are bound, to proclaim the year of Jehovah's favor."§ Divine Fatherhood meant human brotherhood. Jesus set himself to establish an inward, personal kingdom, which he considered as already in the world, and which would gradually leaven all human relations and institutions. Wealth and poverty occupy a large place in Jesus' teaching. The work which he proposes for himself and his followers is redemptive: to seek and save the lost—to change moral outcasts into responsible members of society, to recover wrecked physical manhood, to open for all the abundant life. The spirit

* *Op. cit.,* 343 *et passim.*
† *The Spir. Life,* Chap. V.
‡ Luke 6:46-49; Matt. 7:21-27.
§ Luke 4:16-21; based on Isa. 61:1-3.

of democracy is to characterize the new social order.* A practical love for one's fellows will be its dominant note. The promise of the future is not to the rich and powerful, but to the common man.† One's place in the future life depends on the cultivation of right social relationships.‡

During the Roman and medieval periods this note in the teaching of Jesus was largely obscured. Christianity took on an other-worldliness foreign to the spirit of its Master. While the new religion was an important factor in civilizing the barbarian nations of Europe and laying the foundations of the modern democratic movement, its social activity chiefly spent itself in various works of charity. Outside of the institution of chivalry, the prevailing type of piety was essentially feminine.

The evangelical movements of the eighteenth century brought a new social impulse, but rather in the direction of saving individuals (at home, and later in heathen lands) from a life that would bring future punishment. The emphasis was laid, and is still laid in many quarters, upon heavenly rather than upon earthly relations, upon emotion and contemplation rather than upon activity. This is shown by Christian hymnology. Women have been largely in the majority in the membership of evangelical churches. The lack of the social note has undoubtedly estranged many virile men of all classes. The Socialist Movement,

* Matt. 23:1-12.
† Matt. 5:5.
‡ Matt. 25:14-46.

though probably originating in Christianity, has grown up independent of and largely hostile to organized religion.

The striking characteristic of modern Christianity, particularly in England and America, has been the return to the social emphasis of Jesus himself. The Protestant churches are now taking the lead, not only in philanthropy, but also in all movements for social reform and reconstruction. A new outlet has been given to religious experience along the line of practical, altruistic activity. The recent Men and Religion Movement witnesses to this. The new emphasis is on the community as a whole, and on the individual as a member of the community. In this spirit religious men are beginning to attack the problem of poverty, of a living wage, of sanitation and housing, of crime, of intemperance and sexual vice. Social settlements are found in most of our larger cities. The Salvation Army and similar agencies are working, not simply to convert the outcast, but to find work for him, to train him, to build him up into a complete social unit. The foreign missionary movement, which has grown to such large proportions, now has a similar aim in its work for backward races in other lands.

All that needs to be emphasized here is the fact that this modern social crusade is social because it is religious. It originates as a religious faith, which, like faith in other directions, tends to bring about its own realization. When men pray for the progress of a spiritual Kingdom of God on earth, they commit themselves to such progress, they acquire a new confidence and enthusiasm, an ability to follow out in conscious activity the social impulses which rise above the threshold. The activity itself tells us nothing as to the origin of such impulses—whether they are psychological or supernatural to psychology.

CHAPTER XXIV

THE RELIGIOUS HYPOTHESIS

THE question which confronted us in Chapter XV, as we sought to interpret the psychical group of phenomena, was this: is there mind in the universe apart from brain? The evidence, as far as it goes, indicates that organism, or at least brain, is found only on this planet. Two explanations are possible. First, the human mental phenomena, whose laws furnish the subject-matter of psychology, might be considered to be unique in the universe. Second, the mental life of man might be largely independent of brain and related to other unconditioned mind or minds.

Neither of these theories could be considered an induction, resting on known fact. We were led, indeed, to draw the inference that mind on this planet, and the lower forms of life through which it has come, must be derived originally from mind elsewhere in the universe. But this was a presumption merely; it could be nothing more. Philosophy still lacked the materials with which to construct a satisfactory explanation of being.

What contribution does religion bring to the solution of our problem? Do the religious phenomena so far transcend psychology that they give us actual knowledge of mind in the universe apart from and yet related to the mind conditioned by a human brain?

What is religion? In the preceding chapters we have gathered material bearing on the historical origin of this institution, and studied the principal facts of religious experience. The facts must be allowed to furnish their own explanation.

Religion is primarily an assumption, a hypothesis, a practical explanation of man's relation to the world. The working hypothesis of religion is that there exists in the universe a controlling mind with which human minds are in communication. It is on this general assumption that the religious man acts, consciously or unconsciously. Such a faith inspires his worship, and is expressed both in his prayer and in his activity. Something of the same faith in the universe is seen in other than religious acts, and among men who, in a formal sense, cannot be called religious.

The hypothesis of a spiritual world, as already stated, is not a survival from more primitive modes of thought. Although by no means universal among civilized peoples, any more than the sense of beauty or harmony is universal (the comparison is literary, not philosophical), religion is found today among men of the highest intelligence, and has nearly as strong a hold upon the educated classes as upon the illiterate or the savage. The religious hypothesis is constantly being renewed in the experiences of religious people.

Again, our study has shown that religious experiences, as such, are not to be considered pathological.

This term must be applied to some of the features which occur. Religious hysteria is found among medieval and modern crowds. St. Teresa's visions may have been due to a nervous condition brought about by a naturally sickly body, further weakened by asceticism. The same may be true of George Fox, whose physical constitution, however, seems to have been unusually rugged. But hallucination in itself is not a mark of diseased nerves. And in religious leaders generally, even in the cases just cited, we have remarked an unusual vigor and balance of mind. Furthermore, this increased mentality has been due largely to their religious belief and experience. Religion, until it comes to border on fanaticism, is conducive to mental health, rather than the opposite.

The religious experience in its totality involves that broader "mind" of man which we have seen to include not only his conscious life, but still more that vast subconscious region which, as Professor James has so well said, "is the abode of everything that is latent and the reservoir of everything that passes unrecorded or unobserved. It contains, for example, such things as all our momentarily inactive memories, and it harbors the springs of all our obscurely motived passions, impulses, likes, dislikes, and prejudices. Our intuitions, hypotheses, fancies, superstitions, persuasions, convictions, and in general all our non-rational operations, come from it. It is the source of our dreams, and apparently they may return to it. In it arise whatever mystical experiences we may have, and our automatisms, sensory or motor; our life in hypnotic and 'hypnoid' conditions, if we are subjects to such conditions; our delusions, fixed ideas, and hysterical accidents, if we are hysteric subjects; our supra-normal cognitions, if such there be, and if we are telepathic subjects. It is also the fountain-head of much that feeds our religion. In persons deep in the religious life . . . . the door into this region seems unusually wide open; at any rate, experiences making their entrance through that door have had emphatic influence in shaping religious history."*

The philosophical problem which presents itself, especially in the subject of communion, is the nature of the objective factor in prayer which Miss Strong has called the "alter."

Before entering on a discussion of this problem, it will be fitting that we pause for a moment to pay reverent tribute to religion as an element, even if it should prove to be only an ephemeral element, in the sum total of reality. To consider the part which the religious has played in history may help to give us a truer perspective.

Even if no strictly objective factor in religion could be proved; even if, with the passing of the human race, or with a development of knowledge at present unlooked for and improbable, an objective factor could be disproved, and religion ceased to be, we must still look upon it as an element in the story of the universe unique and unrivalled. The sunset of religion would close a cosmic day of unparalleled splendor. The idea

* *Varieties of Relig. Exper.*, 484.

of God, constantly changing in form, sometimes ignobly anthropomorphic, but rising ever higher and clearer with the advancement of the race, until it combines all that is best in human character and achievement, raised to the plane of the universal and abiding, must stand as the highest achievement of man's intellect. It is religion which has inspired the best that has been thought and written and sung and builded. To it must be ascribed the noblest developments in human character: the self-control, the purity, the honesty, the reverence, the faithfulness, the sense of human brotherhood, the willingness to sacrifice, to subordinate the interests of the individual to those of the race. On religion, as a necessary foundation, human governments and institutions and coöperations have stood. Religion has curbed the passions of men. It has reformed the criminal, and given another chance to the despairing. It has freed the slave, and fed the poor; it has ministered to the orphan, the idiot, the insane. It has lifted backward races and sought to teach every human child. It has deposed kings and created the royal priesthood of democracy. It has sounded the doom of war and militarism. It has demanded, in the name of God and of a divine humanity, the abolition of monopoly and special privilege, and the equality of opportunity. From religion man's chief consolations have been drawn. By it his daily life has been guided, his sorrows have been made endurable and enriching, his sicknesses alleviated or dispelled, his very defeat by the inevitable approach of physical dissolution turned into a song of victory. To ignore the contribution of religion to the life of man on this planet would be to ignore the life of man itself.

Returning to the problem before us, the objectivity of a cosmic mind, it is obvious that prayer itself takes place in consciousness, using that term in a broad sense. It is equally obvious that the supposedly divine "other" is an object in consciousness. Until a stick or a fire or a house or a friend enters our mental life, either above or below the threshold, it is not an object for our experience. The same is true of a god. But the god to whom the worshipper prays, with whom he feels himself to be in communication and communion, may be as distinct from the worshipping personality as the fire or the friend. Are there any criteria by which we can determine whether the god is thus equally objective, in a philosophical sense?

The simplest criterion would be a physical one, through the use of our distance receptors, but this is clearly not available. Ezekiel no more "sees" Jehovah than he sees the wheels with their rims full of eyes.

Another natural criterion is this. Our friend's mental life, as far as we come to know it, is an element in our consciousness, and yet is objective. We know that it is objective because we have found it to be, in its origin, distinct from mental processes originating in other phases of our experience. Our friend has spoken to us, revealing his inner thoughts. It is fairly easy to distinguish this from our dreams of him, our affection, our ideals and hopes. We realize that in certain definite ways our friend's personality has acted upon our own. We have been influenced by him for good or evil. We are different from what we should have been if this other personality had never entered our experience. Does God enter our experience in very much the same way? In other words, is He objective?

The application of this criterion I have attempted in the last four chapters. What is the net result? Excluding as far as possible, by our rules of evidence, the suggestions of the surrounding crowd, of one human personality to another, and of a mind to itself, is there any evidence for an objective mind acting upon the mind of the worshipper?

In prayer and other sides of communion, the sense of the presence of an "other" is remarkably general, strong, and persistent. The intellectual form given to the object worshipped is undoubtedly shaped by suggestion through definite education, public worship, religious writings, and in other ways. Should we consider the "alter" itself merely a projection of our own personality, an ideal self demanded by the "me" for its completion? Such projection and personification is frequent, especially in children. They will invent imaginary companions, and at times exchange parts with them. Similar phenomena appear in dreams, in hypnotism, in the cases of secondary personality. The waking personality itself we have seen to be the playing of a part. But we have also found evidence for a deeper personality, which includes both the conscious and the subconscious, a "mind" which cannot be resolved into a mere succession of changing selves. The "alter", however much it changes, is the same *alter,* ever standing over against the *me.* In almost no case does the *me* exchange places with the *alter,* as with other selves, other *personæ* in the drama of individual experience. The "other" is always treated as objective, just as the personality of our friend is treated as objective. Even when Paul says: "I live, and yet not I, but Christ liveth in me," his own individuality is not lost in the other, but rather heightened by the other's presence and influence.

The acquirement of new knowledge by the religious leader, like other forms of genius, takes place through the emergence of subconscious mental resources and activities into the conscious. The process, broadly considered, is that of auto-suggestion. If there is inspiration in religion, there is very similar inspiration throughout the entire mental experience of man. I merely note here a tendency in the religious experience to render the subconscious resources more readily and constantly available. Other things being equal, the religious man is likely to do better thinking than the non-religious man. Prayer is undoubtedly an aid to discernment and organization. This might fairly be taken as giving some evidence for a closer touch with a cosmic mind, with which all human minds are in more or less intimate relation.

The case is very similar when we consider the physical effects of religion. Auto-suggestion is again the dominant factor. It is the subconscious, as we have seen, which controls functioning and secretion and metabolism, as far as these are under mental control at all. The therapeutic value of prayer and faith suggests a closer touch with the cosmic mind from which the minds on this planet must ultimately have been derived, and on whose universal forces and movements every organism would necessarily be dependent.

Perhaps the strongest evidence for such a relation is furnished by our study of conversion. In the experiences of adolescence and of adult life, religious faith certainly releases forces of moral illumination and improvement otherwise unutilized. It witnesses to a depth of personality, a social nature, a power of social adjustment, of which psychology can give a description, but not an adequate explanation. Puberty and religion are associated in the making of the complete man or woman. There is much to indicate—what religion assumes—the presence of a mind in the universe with which the subconscious mind of man is in the closest possible relation. In the altruistic activities of religion man appears to be working successfully for the creation of a larger and completer world. Is he working in isolation, or, as he believes, in coöperation with a higher Power, in harmony with the universe itself?

The evidence for an objective personality in religious experience, as thus summarized, is indirect and inferential, rather than direct. Even so, its cumulative weight is very considerable. Is it sufficient to justify philosophy in using religion as a working hypothesis for the explanation of the universe?

In the answer to this question the determining factor must be a consideration of the part which religion has played in human history and so in the history of the universe. For this no allowance is made by the purely psychological explanation of religious phenomena, which presents itself as an alternative hypothesis. This offers man no practical help in his adjustment to the universe. Not only so, but it even destroys, in the very act of explaining, such adjustment as is already in progress. The moment the worshipper becomes convinced that the "other" is merely another aspect of his own personality, another grouping of selves, he stops praying; his moral and social achievements are largely at an end. The belief that the "other" is, in its origin, actually external to his own mind, is the condition of his continuance in prayer and other religious exercises and efforts. If Jesus had reached such a conviction, he would necessarily have dropped the phrase "My Father." He must, in common honesty, have given up the religious hypothesis which hitherto had guided his life. The Lord's Prayer and The Sermon on the Mount would never have seen the light. There would have been no New Testament, no Christian Church. The social and political movements which find their source in Christianity never could have arisen, and modern civilization would be impossible.

If narrowly applied, such a consideration as this would be unethical from the scientific and so from the philosophical standpoint. The destruction of superstition by knowledge is no defence of superstition. The fact that only an uneducated Roman Catholic would receive benefit from the shrine at Lourdes could not be used as an argument for the efficacy of the grotto or for the presence of St. Bernadotte. No single religious belief is true merely because it has practical value.

But religion, taken as a whole, may legitimately be considered as a process of adjustment to the universe of which man finds himself a part. This idea of adjustment suggested itself repeatedly in our study of religious experience. Man is born into an environment, partly physical, partly organic, partly social and psychical. The religious hypothesis is primarily a practical one. It is an assumption that the world, and especially the psychical part of it, has a cosmic meaning and connection. It is, further, the assumption that adjustment to this wider spiritual universe is possible. This practical induction is confirmed by the success which has followed such attempts at adjustment. Though man's increasing knowledge and control of physical and biological forces is largely independent of religion, his social adjustments are fundamentally religious. Religion is the basis for his ethics, his institutions, his social passion and progress. On religious faith the highest development of the individual is dependent.

All knowledge, as we saw in our introductory chapter, is relative, not absolute; experimental rather than *a priori;* a succession of probabilities; a constant series of inductions. The relative truth of the religious hypothesis would appear to be shown in the same way as the relative truth of the hypothesis that an external world exists, or that such a world is governed by natural law. To deny the fundamental assumption of science means the death of science and the end of progress in the mechanic arts. To deny the religious hypothesis means the death of religion and the end of progress in social and individual betterment. In each case the induction is based on experience and confirmed by further experience. In fact, these two disciplines are not as far apart as is sometimes thought, either in their attitude or in their objective factor.

Taking the idea of a spiritual universe as a working hypothesis, drawn from the personal and largely subconscious experiences of a great proportion of the race and confirmed by the progress of the race itself and to some extent by the carefully-sifted evidence as to the existence of an external factor in religion, the universe and man's relation to it is given a meaning, increasingly clear and capable of realization. The appearance of life on this planet, the evolution of man, and his cultural history—is no longer a mere "sport" of nature, an inexplicable blossoming of reality in the soil of a barren cosmos, a meaningless harmony breaking in upon the monotone of existence. Man's planetary life becomes the key to the understanding of the whole. Philosophy for the first time is given a working explanation of the world in which we live.

To a sketch of the meaning of the universe, as thus interpreted, I devote our closing chapter. Religion, having been faithful over a few things, may be set over many things, given new provinces of thought to rule, if it can rule them well.

CHAPTER XXV

THE REPUBLIC OF GOD

THAT which before was lacking, any actual knowledge of mind apart from the human brain and nervous system, is now supplied. Religion seems to show us that there is actual communication between the minds of men and the mind which is external to them in the universe. What further inductions may be drawn as to the nature of the cosmic mind, which religious men call God?

1. We are justified in saying that this mind is active. We know it through its activity, through its constant operation in the subconscious experiences of men. It is God (if I may so denote it, leaving the connotations of that term to be supplied as we proceed) who "thinks" with men. The process of inductive reasoning takes place in consciousness. The insight into new meanings and relations, on which induction depends, is primarily subconscious. On the religious hypothesis the discovery of new truth in any sphere, the appreciation of beauty and value, the choices and decisions of practical life, and even, it may be, second-sight and occasional prediction and premonition—are the result of coöperation between two minds, the cosmic and the human. Through this coöperation resources are accumulated below the threshold of consciousness which

man alone, or as a mere biological unit, would be unable to gather. That man who, through the attitude of faith, is most dependent upon and in harmony with God, is best equipped to receive and utilize such resources. It is this which constitutes inspiration and genius, whether religious or literary or scientific, whether intellectual or æsthetic or practical.

It is God who coöperates with the subconscious mind in the proper functioning of the organism, in the control of metabolism and circulation, in the coördination of the nervous system, in the training of the neurones of one or the other cerebral hemisphere that the brain may become an adequate thinking-machine, in the formation of habit, in the recuperation of nervous and organic energy during the hours of sleep, in the relief of nerve tension and the overcoming of hysteria, in the exorcising of fear and worry, in the alleviation and cure of disease. Such coöperation is evidenced by the part which religious faith plays in many of these processes. Man is only beginning to realize the extent of his opportunities in this direction, as a partner with the divine life. It is God who enables a man, through what we call telepathy, to control to a certain extent the organic and nervous processes of another, whether he be present or distant—a power as yet little utilized or understood.

It is God who works with man, through the machinery of distance-receptors, neurones, organs and muscles, to make his daily life a successful adjustment to environment, to enable him to control that environment to a large degree and shape it to his own ends. In such an adjustment faith has been an essential factor. If it is the divinely-inspired genius who discovers, it is the divinely-endowed worker who utilizes physical and biological forces. The result has been a constant creation and re-creation of the world which occupies the surface of this planet. Man found the world simple; he has made it complex. That which once was hostile has become his servant. The earth has seen buildings erected, mountains tunnelled, bridges built; land, water and even air conquered for communication; manufactures and arts perfected; water power and steam and electricity harnessed; deserts reclaimed and marshes drained; plant and animal species domesticated, altered, actually created — for the service of man.

In the reproduction of his own species—a process partly psychical, partly organic—there is evidence of the same coöperation with the cosmic life. Man shares with God the sacred responsibility of creation. Religion, in its control of the sexual impulse, proves itself an indispensable aid to eugenics.

Providence, however it may be directed by God alone, is constantly being shaped by God and man acting together. The average length of human life is being increased through sanitation, improved nutrition, the restriction of child and woman labor, the adoption of safety devices in transportation and dangerous occupations, the destruction of hostile bacteria and their carriers. The conquest of chronic diseases is among the possibilities of the future. Every modern city has its building regulations and its fire service. Even the ravages of flood and earthquake are largely neutralized through quick means of communication and the aid which is at once rendered by those living in more favored localities. Drought and famine in one country call out supplies of food from lands of plenty. For the course of Providence the race increasingly holds itself responsible, in this divinely altruistic age. Through that psychical and organic connection with God which is natural to every man, and through the attitude which religious faith engenders, man proceeds, with confidence and resolution, to form his own earthly life and that of his fellows.

God strives with man—not against him but with him. The cosmic mind is ever ready to coöperate in moral illumination and growth. The closeness of this connection is shown in the normal experiences of adolescence. When the reproductive organs of the youth are functioning—a process with which, as I have suggested, the cosmic life must be directly concerned—the divine life is present to direct the functioning of the personality as a complete social unit—enlightened, controlled, unselfish, with a new sense of the presence and purpose of God. Conversion in later life appears to be merely a case of belated functioning, the formation of a new social personality. The surrender of the self opens the subconscious mind to the operations of divine suggestion. Faith and worship serve the same purpose. Prayer is coöperation with a higher power. When the human and the cosmic mind work in complete harmony, the victory is sure; no habit is too strong to break, no virtue unattainable. That God is influencing the individual, even without conscious religious experience, is shown by the moral richness and capacity of the total personality, even in the most degraded men, when called out by the proper suggestion. It is the thought of God which most commonly releases these God-given resources and puts them at the service of the conscious individual and of the community in which he lives.

God works with man for the service of humanity. Social passion and progress are meaningless until translated into religious terms. Religion has been their inspiration. They are marks of the religious experience in its highest development. Altruism means the recognition of the divine influences constantly acting upon the mind of man, but often unknown or unheeded. To love one's fellows is to be in harmony with the universe. Practical, self-sacrificing service for the community brings results in the improvement of the community life, because it supplements and is supplemented by the activity of God.

2. We know the cosmic mind as purposeful activity. As we study God's operations upon the mind of man, we see that a definite end is being attained—the perfection of the mind, of the total human personality, as a social unit. The development of the physical organism, with its complex brain and nervous system, enables the adult man to adjust himself with increasing success to

his earthly environment, physical and social. The story of the racial life in that environment shows a slow but apparently irresistible progress from savagery to civilization. Inspiration is the key to this process; those peoples progress that can best utilize their God-given resources. With the increasing accumulation of ideas the upward movement grows ever more rapid. We see the gradual socializing of the individual, as civilization advances, the education and improvement of an increasing proportion of the population. The life-history of the modern man, at his best, reveals a growth in knowledge, in resourcefulness, in self-control, in symmetry and poise, in the distinctively social virtues. The direction of the process, in which God has been actively coöperating, marks the general direction of God's activity.

That the aim of the cosmic mind has been the perfection of the human individual or of the human species is shown by the history of the universe itself, as far as we are able to trace it. Though the presence of a highly-developed life in other worlds might easily be fitted into the conception which philosophy derives from religious experience, we do not, as a matter of fact, have any evidence of such inhabited worlds. All the evidence available points in the opposite direction. No other planet in the solar system is fitted for life; no other sun is known to have the same planetary system. Thus far our earth is unique in the heavens.

Modern astronomy, strangely enough, appears to be returning to the idea of a geo-centric universe. Our solar system lies in the center of the stellar world, where stars are few and cataclysms infrequent. Around it in all directions are the bodies which make up the flattened sphere of the physical universe, grouped in various systems of clusters and drifts, and passing through their cycle of change from nebula to sun and from sun to nebula. Circling the universe is the vast belt of the Milky Way, with its crowded stars, seldom living long enough to pass through more than the first stages of stellar evolution. Stupendous as the idea seems, the suggestion forces itself upon us that the effect of the stellar system, with its countless millions of stars, is, by the interaction of gravitational forces, to hold our central sun poised in its orbit. The uniqueness of our planet, the supreme value of the mind of man, the interest of God in man's social history—would indicate that, as the physical universe exists for the solar system, the solar system exists for our planet. Man would thus become the central fact in the plan and purpose of the universe.

To a more detailed study of the divine purpose I shall return at a later point. We are at present concerned rather with the nature of the cosmic mind itself.

3. We know the cosmic mind as one, not many. In our study of the physical sphere of reality, we found it to consist of an inconceivably vast number of centers of force, in incessant movement, in constantly changing relations. These force-centers are not mutually independent, but are organized into more or less permanent groupings—as atoms, molecules, masses, heav-

enly bodies. These various units constitute an interacting system, the uniformity of whose operations forms the basis for what we know as natural law. This physical system we were compelled to consider as a totality, a dynamic unity, a universe.

When we passed to the organic group we found that the appearance of life on this planet can be explained only by the presence of life elsewhere in the universe. At the same time we noted the close and necessary connection between physical phenomena and the phenomena of life. The organism is physical; it is made up of physical units, following their appropriate laws. The environment in which it lives is primarily physical. In its reaction to that environment the living organism, to a certain degree, controls physical forces and utilizes physical energies. We were compelled to think of the universe in a wider sense, as comprising both energy and life. Because of the interrelation of these two factors, we may go further and say that the universe, or the universal energy, not only follows the uniform laws of physical activity, but also the less uniform, more self-directed operations which we note in the activity of planetary organisms.

The study of the psychical group of phenomena, with its outgrowth in the religious experience of man, enriches but does not essentially alter this conception of the universe or of the universal energy. Man is an organism, and so is fundamentally physical. The brain which he utilizes is a physical machine. Through such machinery he controls his own organism and the physical and biological environment. On the other hand, the mental life of man witnesses to a cosmic mind, an energy still less uniform in its operations, still more self-directed and purposeful, than we could infer from the study of lower forms of life. There is no occasion to distinguish between the cosmic mind and the universe. As a general concept, built out of the facts of our experience, the first of these terms is only a further definition of the second. God is one, because he is identical with the universe.

4. Is the cosmic mind to be thought of as a personality? The question is largely one of terms, and this term is a rather illusive one. We must be on our guard against the error of the *a priori* philosopher, with his conception of the absolute. Into this term, as into a juggler's hat, he would pack such abstract and utterly meaningless attributes as omnipresence, omnipotence, omniscience, and so forth, and then proceed to draw out these qualities for the amazement of the vulgar. What we are seeking, by our inductive method, is not what God might be, in the imagination of some cloistered student, or what God ought to be, according to the ideal of the theologian, but what God actually is, as shown through our experience.

With reference to the present question, we know God as a unity, comprising all reality with the possible exception of organism. We know him as energy. We know him as activity, as purposeful activity. This purpose is moral and social. The God whom we know thinks and strives and achieves with men. If this constitutes personality, then God is a personality. It would be safe to say that the cosmic mind is at least as much of a personality as the "mind" of man.

5. If God is identical with the universe, our abstract friends will ask: "Is he limited by space and time?" There is no reason to resurrect the concept of space, after the decent burial which we gave it in our fourth chapter. It was done to death by the scientific doctrine of relativity. Even the measurable relation into which we resolved it has no meaning outside of the physical sphere of reality, and this, as we know, is only a partial and, it may be, a passing manifestation of the divine activity.

The concept of time is less easy to deal with. The "measurable sequence" of our every-day life can have only a physical meaning; the units for its measurement are furnished by the passage of light. As we are physical organisms, with physical brains, we necessarily think of sequence in physical terms. What sequence means in other spheres we have at present no basis for conceiving or understanding. Any discussion of beginning or end, of an eternity *a quo* or an eternity *ad quem,* is on a par with the fairy lore of childhood. What we know in the universe is an activity and a process.

6. What is the relation of the cosmic mind to the units of biology? We as yet know too little of the nature of planetary life to expect a complete and final answer to this question. The single-celled protozoön is an organism, a grouping of many highly complex

molecules into a whole which has the power of transforming physical energy, so as to carry on the functions of movement, metabolism, reproduction and probably variation. The metazoön, lower or higher, is likewise an organism. The initiation and control of life-functions is no longer carried on by the single cell, but by all of the cells, or the more important of them, acting as a unit. Certain specialized cells or groups of cells are used for certain functions. Apart from the organism the cell soon dies, at least in the case of the higher animals, because it is not capable of carrying on independently the processes necessary for life.

The unity and self-direction of the organism seems to indicate a certain independence of the universal life, which might be said to have limited itself in the creation of life on this planet in order to carry out a higher purpose. That purpose we have seen to be the creation and perfection of man.

The whole history of evolution bears out this inference as to the independence of organisms, and it may therefore be considered a legitimate induction. Organic evolution is essentially different from the evolution of the stars, for instance. The latter is constant, certain, uniform. The former is intermittent, uncertain, go-as-you-please. Given definite materials and forces, the astronomer could predict the exact course and duration of the condensation of the nebula into a sun, its rise in temperature through contraction, its cooling into a dark star. Given an evening primrose in a perfectly definite environment, not even de Vries could predict that it would mutate, or what particular mutations would arise.

To use a simple parable—it would seem as if God said to the protozoön: "I have endowed you with certain powers. I have given you this environment, partly favorable, partly hostile. See what you can make of yourself. Rise; I will help you." Millions of years passed. The original protozoön assumed many different forms, but still it was but a single cell, capable of only the simplest functions. The Great Biologist watched and waited. And at last his patience was rewarded. One of the protozoa became a colony of cells; the colony became a many-celled organism. And to the first metazoön God said: "See what you can make of yourself. Rise; I will help you." Through the ages the Master Mind watched the evolution of plant and animal forms—now forward through rapid and successful mutation—until the species which showed such promise became over-specialized or unsuited to its environment and yielded its proud place to some humbler species better fitted to advance. The vertebrates came at last, the mammals. Was the end at hand? To the first anthropoidea the Master spoke the same challenge: "Rise; I will help you." The monkey came, the giant ape, mightier than any animal that had gone before. But again there was over-specialization. The chance was gone; the door of progress was closed. But soon, in one of the still generalized anthropoidea, there came another series of mutations. A new species arose, walking erect, with more complex brain, using its new-found hands, fond of play, gregarious, hunting and fighting in packs, communicating by rude sounds. The Master listened. "My little child has said its first word," he said.

Beyond some such figurative description we cannot go, in the present state of our knowledge, especially on the subject of variation. That God was concerned in the process is clear. From him life must have come. He furnished the environment; he was the environment. We must think of him as coöperating with organism at every stage of the process. All the power of the universe was on the side of the individual which started to rise. That the cosmic mind left to the organism itself much of the direction of the process—even perhaps the control of mutation, on which the whole process depended—is suggested not only by the ups and downs of the evolutionary process itself, but by the useless characters found in almost all species and by the presence of many forms of living creatures actually harmful to man.

7. This conception is of the greatest value when we pass to a more detailed consideration of the relations between the cosmic mind and the minds of men. Like other organisms, man is a unit—self-directed, self-adjusting, capable of activity and control. The human individual stands in much the same relation to the universe as the individual of the lower species. He is independent of God, though in closest touch with him. The cosmos in this sense is plural, not singular. Many millions of minds today, countless billions of minds in

the course of history, have been coöperating with the Master Mind in the divine purpose—the creation and perfection of the human race.

Is the concern of the cosmic mind with the race or with the individual? What is it that has inspired the marvellous complexity of the physical universe, the evolution of the stellar system, the preparation of this planet for life, the evolution of organic forms until the climax is reached in man? Has the purpose ever governing the divine activity been the gradual perfecting of society as a whole, or of the individual units which compose society? We see both processes going forward in the course of history. Is it possible for us to determine which of the two has been dominant?

The divine purpose is certainly not the further perfecting of the human species along physical lines. The end has been reached; organic evolution is closed as far as man is concerned. Such mutations as still occur, in stature, complexion, physiognomy, make no essential difference in man's physical structure or in his relation to the environment. The Australian, though another elementary species than the Frenchman or the Englishman, has equal powers of adjustment and development. The differences between races and between individual men are those of opportunity, of training, of mental accumulation and habit.

God's dealings with the race have been through the individual. It is the inspiration of the individual genius which has discovered new truth, made advances in the arts, founded and improved human institutions.

It is with the individual that God has striven and loved and labored. Having the universe as his environment, with the cosmic energy ever ready to supplement his own feeble efforts, with the divine mind to suggest and reveal, each man has been responsible for his own advance or decline. While the race as a whole has progressed, at least as far as accumulation is concerned, the individuals start at the same level. Their progress is not inherent and assured. They may accept their responsibilities in Central Asia, as in civilized America. They may shirk their responsibilities and become social parasites as easily in London as in Athens or Babylon, in the Amazon wilderness or the Andaman Islands. It seems clear that the activity of God has been directed toward the perfecting of the individual rather than of the race.

It is equally clear, however, that the improvement of the community has been a most important—indeed, an essential—factor in the improvement of the individual. Man's training has been as a member of society, never in isolation. Adolescence and the accompanying religious experience mark the socializing of the child, the development of a complete social unit. The unsocial child or man is the incomplete child or man. Social responsibilities call out the best that is in him. The further evolution of the human species has been the evolution of environment. The civilized man is more likely to advance than the savage; he may reach a vastly greater mental and moral development. To improve social conditions, to eliminate evil surroundings, to give the child or the savage a better chance in life—all the altruistic movement of modern times, in which God is so closely coöperating—makes for individual growth and betterment. The purpose of God's activity may be further defined as the perfecting of the individual through the evolution of a higher social order.

8. Let us look more closely at the mind of man with which the cosmic mind is in relation. Above the threshold we see the waking personality, slowly learning its part. That part is largely the adjustment to a physical environment. For such adjustment the conscious person makes use of his distance-receptors, his brain, his nervous and organic machinery. With constant aid from beneath the threshold of consciousness, constant drawing on his subconscious resources, he learns to play his part and play it well. He comes to know and control his environment, as material civilization bears witness. He mingles with his fellows as a member of a complex social order. But his horizon is an earthly horizon. He thinks largely in physical terms. With the wearing out of the physical organism, his adjustment becomes incomplete and uncertain. Death is the end of the play. Man must needs lay down his part as an organism, as a waking personality who uses his physical brain to see and hear and respond.

Beneath the threshold is the vast realm of mental activity which we are beginning to know as the subconscious. It is here that the experiences of the waking personality are registered and matured. The subconscious is the seat of memory. It is the source of habit. It is the fountain-head of discovery, of emotion, of resolution. Here are found powers and virtues unrecognized by the waking personality or by one's fellow actors. In this realm man spends one-third of his life, while the curtain of the earthly theater is drawn. In the market-place of the subconscious, man meets other minds; influences them and is influenced by them. Here, as in a royal presence-chamber, he meets his God, hears the voice of divine suggestion, enters into alliance with the universe. This deeper mind grows richer with the passing years. The decline of the physical organism may cut off news as to the drama that is being acted, haltingly and feebly now, in the outer world, but it in no way diminishes the resources of the life within. When the curtain falls—in the very hour of death the mind of man frequently exerts its most powerful influence upon the mind of others, in greeting or monition. That such communication does not end at death is suggested by the rapidly-accumulating evidence (though not by the direct experiments) of psychical research.

The perfecting of the individual is the perfecting, not primarily of the incomplete and ephemeral waking personality, but of the larger and deeper mind below the threshold. Except for its education through the activities of the conscious personality, this mind appears to be no more dependent on a physical organism than is the cosmic mind itself. The purpose of God is the training of the "mind" and the development of its latent powers.

9. In the spiritual universe, which includes both the cosmic mind and the minds of men, there is the beginning of a higher social order—a republic to use Elisha Mulford's phrase—in which God may find his fullest satisfaction and man his complete development. This diviner order is still ideal. It requires for its realization the coöperation of men. The creation of a spiritual universe is still in progress. But it has begun. Even during his earthly life, the human mind is sharing, conciously or unconsciously, in the making of man, in the discovery of his own powers, in the shaping of a social environment.

The universe, as far as our fragmentary and imperfect experience enables us to picture it, begins as a cosmic mind, unorganized, unsocial, but capable of organization and filled with a social hope and plan and power. The cosmic mind organizes itself in the dependent units of the physical universe: in those centers of force which we know as electrons, in those groups of such centers which, through their relations, we know as atoms and molecules and masses and stars. The cosmic mind limits itself as the universe further unfolds. It limits itself first in the semi-independent units of biology: in the cell and the organized group of cells, which are closely related to the physical units and pass back into the physical, or perhaps merely cease to be as their peculiar relations cease. The universe consists now of many separate lives, and yet is still, in a sense, one life. With the evolution of man the cosmic mind further limits itself. The universe comes to be a republic—no longer one mind but many—a spiritual order in which each man holds citizenship and to which he owes allegiance.

The religious hypothesis has guided us hitherto in our philosophical interpretation of the world of reality, suggesting to our thought meanings and relations that we could not otherwise have obtained. It is in the presence of an uncompleted and still ideal universe that religion faces, and meets I believe successfully, its supreme test. To each man born on this planet comes the call and the opportunity to take his place in a higher spiritual order, to become in his character and his aim, in his knowledge and his satisfactions, like the Master Mind whom we call God. Will he take the place which may be his, not merely as a member of a spiritual republic on earth, progressively realizing the plans of God for humanity's physical and social training-ground and for humanity itself, but also in that wider world of mind in which the physical is no longer necessary or useful? Or will he, now or in the world beyond, fail of his calling and sink back, like the mere unit of biology that he is in part, into the universe from which he has come?

It is in enabling man to take his place in the Republic of God that religion shows its abiding worth. It proves itself the key to the meaning of the universe, because it is the practical means of realizing that meaning. Faith is the evidence of things unseen, because it is ever giving substance to things hoped for. Through man's coöperation with God the higher order comes to be a fact of our daily life, the work of creation goes forward, and our hope glimpses an unlimited future progress. Faith is the portal of the highest reality. Religious experience unlocks a door that, once it is opened by the aspiring and achieving mind, no power may close again.

Such is the universe, and it doth not yet appear what it will be.